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13 *Attorneys for Plaintiffs and the*
14 *the Proposed Class*

15 UNITED STATES DISTRICT COURT
16 NORTHERN DISTRICT OF CALIFORNIA
17 SAN JOSE DIVISION

18 IN RE SEAGATE TECHNOLOGY LLC
19 LITIGATION

No. 3:16-cv-00523-JCS

20 DECLARATION OF SHANA E.
21 SCARLETT IN SUPPORT OF
22 PLAINTIFFS' SECOND
23 SUPPLEMENTAL BRIEF IN FURTHER
24 SUPPORT OF CLASS CERTIFICATION

25 DATE: June 15, 2018
26 TIME: 9:30 a.m.
27 DEPT: Hon. Joseph C. Spero
28 Courtroom G, 15th Floor

1 I, SHANA E. SCARLETT, declare as follows:

2 1. I am an attorney duly licensed to practice before all of the courts of the State of
3 California. I am a partner with the law firm of Hagens Berman Sobol Shapiro LLP, the attorneys
4 for plaintiffs in the above-titled action. I have personal knowledge of the matters stated herein and,
5 if called upon, I could and would competently testify thereto.

6 2. On April 24, 2018, Seagate produced 1,034 new documents to plaintiffs (“Seagate’s
7 First New Production”). Seagate’s First New Production begins on page FED_SEAG007862 and
8 ends on page FED_SEAG0090892 – more than 8,000 pages. Until April 24, 2018, plaintiffs did not
9 have access to the documents contained in Seagate’s First New Production. As a result, this
10 evidence could not be included in plaintiffs’ briefing for class certification.

11 3. After the Court’s May 1, 2018 Order Regarding Production of Spreadsheets (ECF
12 No. 172), Seagate produced an additional 2,409 on May 4, 2018 (“Seagate’s Second New
13 Production”). Seagate’s Second New Production begins on page FED_SEAG0090896 and ends on
14 page FED_SEAG0093491– more than 2,500 pages. Until on May 4, 2018, plaintiffs did not have
15 access to the documents contained in Seagate’s Second New Production. As a result, this evidence
16 could not be included in plaintiffs’ briefing for class certification.

17 4. Seagate produced an additional 211 documents on May 8, 2018 (“Seagate’s Third
18 New Production”). Seagate’s Third New Production begins on page FED_SEAG0093523 and ends
19 on page FED_SEAG0096051– more than 2,500 pages. Until May 8, 2018, plaintiffs did not have
20 access to the documents contained in Seagate’s Third New Production. As a result, this evidence
21 could not be included in plaintiffs’ briefing for class certification.

22 5. Seagate then produced an additional 51 documents on May 20, 2018 (“Seagate’s
23 Fourth New Production”). Seagate’s Fourth New Production begins on page FED_SEAG0096052
24 and ends on page FED_SEAG0096694 – more than 500 pages. Until May 8, 2018, plaintiffs did
25 not have access to the documents contained in Seagate’s Fourth New Production. As a result, this
26 evidence could not be included in plaintiffs’ briefing for class certification.

6. In total, Seagate has produced 3,705 documents since April 24, 2018. These four productions contain more than 15,000 pages of evidence that plaintiffs should have had access to prior to filing for class certification. Because of Seagate's delay, plaintiffs were forced to review this new evidence on shortened time, plaintiffs' expert was precluded from analyzing these documents, and this evidence could not appear in plaintiffs' certification briefing.

7. Attached hereto are true and correct copies of the following exhibits:

Exhibit 72: Plaintiffs' summary chart of customer complaints pursuant to Federal Rule of Evidence 1006;

Exhibit 73: Excerpts from document Bates-numbered FED SEAG0072901-73137, produced in the above-captioned litigation and designated "CONFIDENTIAL" by Defendant Seagate pursuant to the protective order in this action;

Exhibit 74: Excerpt from document Bates-numbered FED SEAG0090966, produced in the above-captioned litigation and designated "HIGHLY CONFIDENTIAL – ATTORNEYS' EYES ONLY" by Defendant Seagate pursuant to the protective order in this action;

Exhibit 75; Excerpt from document Bates-numbered FED SEAG0094984, produced in the above-captioned litigation by Defendant Seagate in this action;

Exhibit 76; Document Bates-numbered FED SEAG0072901-73137, produced in the above-captioned litigation and designated "CONFIDENTIAL" by Defendant Seagate pursuant to the protective order in this action;

Exhibit 77; Documents Bates-numbered FED SEAG0086631-674, produced in the above-captioned litigation and designated "CONFIDENTIAL" by Defendant Seagate pursuant to the protective order in this action; and

Exhibit 78; Seagate Desktop HDD Product Manual, *available at* <https://www.seagate.com/www-content/product-content/barracuda-fam/desktop-hdd/barracuda-7200-14/en-us/docs/1006865841.pdf>.

I declare under penalty of perjury under the laws of the United States that the foregoing is true and correct. Executed this 5th day of June, 2018 at Berkeley, California.

s/ Shana E. Scarlett
SHANA E. SCARLETT

EXHIBIT 72

In Re Seagate Technology LLC Litigation
Case No. 3:16-cv-00523-JCS

Plaintiffs' ER1006 Chart
Summary of Seagate's Voluminous Records
Emphasis added unless otherwise indicated

Date	Drive Name	Excerpt or Summary	Bates No.	Description
2011-02-01 to 2011-03-01	Internal Drive External Drive GoFlex	<p>Sample Complaint: "@AskSeagate appreciate that. Having to RMA a (refurbished) DOA drive that is itself a RMA for DOA drive is totally inexcusable."</p> <p>Sample Complaint: "@AskSeagate the fact I've got to pay for a replacement on a replacement is a bit insulting to begin with. Plus no multiple unit returns."</p> <p>Sample Complaint: "Kylie-Yes, I called Seagate. Explained the situation and was informed that the drive had crashed. I believe I explained in the Seagate Facebook thread my experience with your customer service rep. I am a very well composed individual. However, I was very emotional and brought to tears knowing the fate of my hard drive and the last 13 years of photographs on it. The sympathy and understanding or lack there of from your agent was extremely disappointing. I had expected alot more from your company. I had expected you to stand behind your product, instead I was told how lucky I was that I was in the 4% failure rate. No, I can tell, I did not feel lucky at all. He told me I could send my hard drive into your data recovery, he then proceeded to give me their ballpark prices. This was insult to injury. I buy your product,take it out of the box, back up my hard drive on it, it immediately crashes and then you expect me to pay your data recovery team to retrieve my data off it. Seriously? If that's the serial number you have on file...that must be the one. The firm I sent it to in Boston did take the exterior case off, obviously, they needed to run diagnostics and such on it to give me a fair/accurate estimate on recovery. And before you say it, yes, I understood that by doing this it voided the manufactures warranty. But at that point, the last thing I wanted was a replacement of your external hard drive. I can tell you I will NEVER ever buy your product again. Apparently multiple CD back up is the only way to go, archaic as it is, it works and is dependable. I was using Windows XP."</p>	FED_SEAG0076 611	Internal Seagate Spreadsheet tracking customer complaints for 30 days on Twitter

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Summary of Seagate's Voluminous Records
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Date	Drive Name	Excerpt or Summary	Bates No.	Description
2011-04-06	GoFlex Mac	<p>Sample Complaint – GoFlex Mac: “Just didn't work on my Macs I have a Mac Pro (desktop) and a Macbook. I couldn't get the 3TB Seagate Goflex drive to mount properly, ever. Usually it just sent my system into kernel panics and crashed the thing. Occasionally I could plug it in and fire up Disk Utility to try to reformat the drive for the Mac, but when I asked Disk Utility either to verify the drive or to format it the system would again crash. I tried all kinds of different combinations and permutations: USB, firewire, the desktop, the laptop, different cables, different electric sockets. All led to the same result: plug the hard drive in, and the system crashes. Well, that's FAR more headache than an external drive is worth. An external hard drive should just mount and then work. So: back in the box you go, back to Amazon! I am hoping Western Digital has a better solution for me.”</p> <p>Sample Complaint – “The Freeagent GoFlex packaging is just a data disaster waiting to happen. My drive was not performing normally within a few days of plugging it in. I suspect it would have failed entirely due to heat within a few weeks. This is very, very poor design; a few cooling vents would have done wonders. As it is, I ended up without a mobile drive because I had to tear it out of its external packaging to get it to work reliably. I'd strongly recommend looking elsewhere if you plan to use this drive in any way that presumes long periods of powered-on running time; it's basically useful only for those that will plug it in once in a while to run a backup before unplugging it and putting it away again. And if you run a Mac, don't even buy the drive for that, unless you're willing to repartition and reformat first so that you're not stuck with the NTFS filesystem and Paragon NTFS drivers.”</p> <p>Sample Complaint: “Failed in 2 days...:-(, Not sure if I just had bad luck. I got this 3TB drive 3 days ago and copied my data from 1TB Seagate external drive. Next day I started seeing read-write errors on some files. Later I saw the drive is getting disconnected from the PC. I cannot</p>	FED_SEAG0093 297	Seagate document recording customer reviews on Amazon from 1/1/2011 to 4/7/2011

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Date	Drive Name	Excerpt or Summary	Bates No.	Description
		browse the folders any more. So far, the drive powers on. If I reboot the PC and power cycle the drive, it works for few minutes and again I having read-write issues with files and getting disconnected later. I am a huge Seagate fan. I am using my Seagate 1TB external drive for around 3 years without a single block error. Never expected such a bad drive from Seagate. I am trying to find how can I get a replacement as it failed within 24 hours of use. I would prefer to not buy this specific model again."		
2011-08-12 to 2012-02-08	Barracuda Goflex Desk Expansion Desk GoFlex Home	<p>Example Review - Expansion Desk: "I bought this product because I thought it was a reputable company and the price was good. It stopped working after a month and I lost all data I put on the file. I have two old Western Digital hard drives th[remaining portions of review cut off from document]"</p> <p>Example Review – GoFlex Desk: "I purchased this drive about three weeks ago and it was DOA [Dead on Arrival]. I contacted the company and for ten bucks they would replace it. I've had this new one since and it just died after a couple of weeks use. I paid for th[remaining portions of review cut off from document]"</p> <p>Example Review – Barracuda: "It is not reliable! August 10, 2011 review is correct . the same thing happened to me and I dod follow the same path.1 TB of data gone forever. I bo[remaining portions of review cut off from document]." Seagate's public response to Example Review: "Dear Vauled Seagate Customer, This reply is from Seagate Support. We noticed your review and wanted to comment on your experience with our Barracuda drive. The kind of problems you experienced with your Barracuda drive are not typical. In the future, if you should ever have any problems with your drive I would contact us first. . ."</p>	FED_SEA00769 36	Internal Seagate document tracking 954 negative customer reviews for drives on Amazon, Bazaarvioce , and Best Buy between 2011 and 2012.
2011-2016	ST3000DM001	5,826 mentions of drive failures in spreadsheet	FED_SEAG0093 523	Spreadsheet detailing 46,960

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Date	Drive Name	Excerpt or Summary	Bates No.	Description
		<p>Example Complaint: "As for the external enclosures, we have never taken a drive out of an enclosure to use. Every hard drive that has been purchased were completely new and internal only. These drives were purchased from Newegg and Amazon with an advertised and promised 3 year warranty. If you look back onto the first tickets I have submitted, Seagate has apologized and updated the warranty whether they were internal or from an external enclosure. You cannot advertise one thing on Newegg and then change your policy midway because of the abysmal failure rate of these 3TB HDDs. These hard drives were purchased on the promise of a 3 year warranty, where it came from isn't a concern for the consumer, especially when these are all internal hard drives."</p> <p>Example Complaint: "However, the replacement drive has also failed, and an another drive of the same kind has failed. Of the 8 seagate drives I've purchased of this type, four have now failed within six months and I question whether I want a replacement of this kind of drive or would be better off with a different kind of drive considering the 50% failure rate this model has. Can I get a different model, one that will be more robust and long lasting than this model? Is the failed replacement covered under warrantee?"</p> <p>Example Complaint: " This is unacceptable. I'll quote below from the Amazon sales page under the section entitled From the Manufacturer: 'Ideal for Any Application From desktop or all-in-one PCs, to home servers, to PC-based gaming systems and more, Seagate Barracuda drives are ideal for nearly any application. They work great in desktop RAID configurations, as well as in direct-attached external storage devices (DAS) and network-attached storage devices (NAS).' http://www.amazon.com/Seagate-ST2000DM001-Barracuda-3-5-Inch-Internal/dp/B005T3GRN2 I have already laid out the money to buy three of these drives after your advertising told me that they would work 'great'</p>		customer email complaints to Seagate

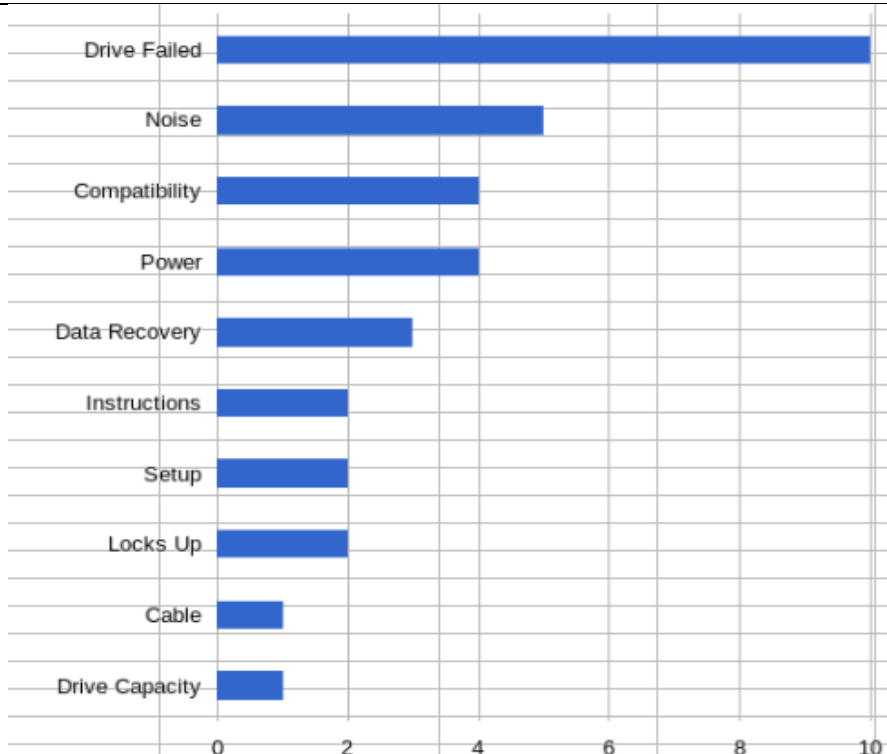
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Date	Drive Name	Excerpt or Summary	Bates No.	Description
		<p>in a desktop RAID configuration. What is Seagate's remedy for this situation?"</p> <p>Example Complaint: "Well I trusted this disc to be my backup. Regarding the notion that I should have several media backups, would you be able to recommend a disk made by a reliable manufacturer that I could use with confidence to store my data? Someone, unlike Seagate, above the industry standard. Further more, how many backups is one supposed to have these days, to accommodate for poor manufacturing and mechanical failure of the disc within just months of use. Maybe this is how 'industry standard' helps boost sales numbers. Since manufacturer can not be held liable for poor product quality, the onus is, indeed, on the end user to make sure to prepare not one backup disc, but three, plus a cloud option (or two) and just hope for the best in case of problems, all the while shelling out the \$\$\$My apologies to you, I really have no quarrel with you but I had to vent somewhere in hope that this will get to those that have deciding powers. I can also only hope that, with time, disgruntled users will stop buying from such standardly non-labile irresponsible companies. I am sure Seagate already knows that one unhappy customer will, on average, tell nine more about their experience.Please proceed with the instructions on how to send the defective drive back"</p>		

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Date	Drive Name	Excerpt or Summary	Bates No.	Description																						
2012-12-14 to 2013-01-13	Expansion Desk	 <table><caption>Data for Expansion Desk Chart</caption><thead><tr><th>Issue</th><th>Frequency</th></tr></thead><tbody><tr><td>Drive Failed</td><td>10</td></tr><tr><td>Noise</td><td>5</td></tr><tr><td>Compatibility</td><td>4</td></tr><tr><td>Power</td><td>4</td></tr><tr><td>Data Recovery</td><td>3</td></tr><tr><td>Instructions</td><td>2</td></tr><tr><td>Setup</td><td>2</td></tr><tr><td>Locks Up</td><td>2</td></tr><tr><td>Cable</td><td>1</td></tr><tr><td>Drive Capacity</td><td>1</td></tr></tbody></table>	Issue	Frequency	Drive Failed	10	Noise	5	Compatibility	4	Power	4	Data Recovery	3	Instructions	2	Setup	2	Locks Up	2	Cable	1	Drive Capacity	1	FED_SEAG0076 706	Internal Seagate document tracking Expansion reviews Amazon, noting that Drive Failures are most common complaint
Issue	Frequency																									
Drive Failed	10																									
Noise	5																									
Compatibility	4																									
Power	4																									
Data Recovery	3																									
Instructions	2																									
Setup	2																									
Locks Up	2																									
Cable	1																									
Drive Capacity	1																									
2012-12-14 to 2013-01-13	Expansion Desk	Sample review: “I purchased this 3 TB Seagate drive in October. Used it as a data backup for photographs, keeping the drive on my desk (not moving it) so in good conditions for such equipment. (I carry smaller	FED_SEAG0076 615	Internal Seagate document																						

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Plaintiffs' ER1006 Chart

Summary of Seagate's Voluminous Records

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Date	Drive Name	Excerpt or Summary	Bates No.	Description
		drives in my backpack with my camera and laptop. After ten weeks the drive stopped working. Under warranty, Seagate will replace the drive, but they want me to pay them to try to recover the data. Personally I don't think this is acceptable. I find the lack of reliability and Seagate's unwillingness to warrant the function of the drive -- data storage -- unacceptable." Sample review: "After 2 days faint beeping sound, won't recognize. Don't have access to my data. Seagate wants for recovery \$599.00 - \$1800.00+"		tracking Expansion reviews Amazon, noting that Drive Failures are most common complaint
2013-02-09 to 2013-07-22	Expansion Desk Backup Plus Desk Backup Plus Mac	Sample Review: "The price is right, but it died within 2 months..., Bought May 6th, fully dead and unrecognizable by multiple computers by July 15th. The seagate analysis tool wouldn't even recognize it. Thank goodness the mfr warranty lasted 3 months. Or maybe I should say thank goodness the drive only lasted 2 months instead of 4, or I'd be out of warranty and out \$130 (the price I bought it at).For comparison, my other Western Digitals of the same size I bought in fall of 2011 - one's still going strong, the other one died about 2 months ago." Sample Review: "Lost all data., Things I had for years all gone, i'll never buy another Seagate product again , sad thing is I did like them at first but now all of my Seagate hard drives are dead along with my all data never again, all my years down the drain. Some say it's Windows 7 but my WD and Maxtor hard drives works fine." Sample Review: "Stopped working on day 1., Stopped working on day 1 while trying to do a backup. Something happened and the power flicked on and off and that's when it stopped working. Could not recover it or repair the desk or anything--it was bricked. This didn't help my fear that many friends shared with me when their seagate hard drive's failed on them too. Would not go with seagate again."	Fed_SEAG00766 09	Internal Seagate document tracking 1,738 Amazon reviews and Seagate's public responses

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Plaintiffs' ER1006 Chart

Summary of Seagate's Voluminous Records

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Date	Drive Name	Excerpt or Summary	Bates No.	Description
2013-09-20	Expansion Desk GoFlex Desk GoFlex Mac	Seagate Communication "Hi Team - John received call today from Rose Ginther [contact information redacted]. Rose explained that her back-up drive failed. She spoke to customer service re: the Warranty - which she understands will replace her drive (it is a couple months old) however in order to get her data off the drive - that will end up costing her upwards of \$3,000. She is freaking out (her words) because of the valuable photos on this drive (family members who have passed away). She does not have \$3,000 to recover these photos. Please review her case and help where possible. Thank you! Krista"	FED_SEAG0093 489	Seagate spreadsheet detailing direct customer complaints
2014-01-01 to 2016-12-30	Expansion Desk Business 1BAY NAS Business 2BAY NAS Buisness 4BAY NAS	8,049 complaints of drive failures	FED_SEAG0093 490	Spreadsheet detailing 102,135 customer complaints to Seagate – all complaints are for drives at issue
2014-03-01 to 2014-12-31	Barracuda BackUp Plus Desk Expansion Desk Expansion Desk Plus Business Storage 1 BAYNAS FreeAgent Desk	<p>Sample Complaint – Barracuda : "If you even have a Q/A'r looking at these..... I had a completely healthy harddrive die, sent in to receive warranty replacement, and received one back of similar calibre(shitty 3 tb for 3tb) but ended up with a drive that only had 840gb out of 3 tb.... My confidence in you is completely gone, and all you would have had to do was send me an upgrade to the crappy drive you already tried feeding me. Im going to Hitachi, thanks for nothing"</p> <p>Sample Complaint – Expansion Plus: "I purchased a Seagate external drive and placed the digital photos of my daughters birth on it. The device died within five months of purchase, clicking. You'll replace the hard drive but you want to charge me five hundred dollars to attempt to</p>	FED_SEAG0076 525	Internal Seagate Spreadsheet tracking customer complaints directly to Seagate Customer Service

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Plaintiffs' ER1006 Chart

Summary of Seagate's Voluminous Records

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Date	Drive Name	Excerpt or Summary	Bates No.	Description
		<p>recover the data that is lost because of your crappy product? I will never ever purchase another Seagate product. I'm a sysadmin in charge of a decent sized san. Western Digital and Hp thank you. Rediculous!!"</p> <p>Sample Complaint – Barracuda: "Most of your survey questions aren't applicable to my current experience. However I bought 8x SV35 hard drives from you thinking seagate was a reputable company. Of those 8 drives I've experienced a 100% failure rate. You can check the RMAs on them. I bought these drives as they are advertised as being NAS drives and a 24/7 environment drive. All drives are strictly storage so their actual use and access read / write is minimal at best and spend most of the time spun down. Right out of the box o"</p> <p>Sample Complaint – GoFlex Desk Mac: "Your Hard drives don't work correctly. I am Waiting for My 3rd Hard Drive."</p>		
2014-03-27	Business Bay 4 NAS	Sample Review – Business Bay 4 NAS: "Out of three of these that have been online for less than 6 months, 2 have developed problems that require an RMA. The last issue took out three of 4 drives. One was under warrantee, the other two are door stops now. Buy at your own peril. To add insult to injury, they are closed for the holidays. Business critical files on your box? too bad...see you after the party folks."	FED_SEAG0094 986	Spreadsheet of Business Bay 4 NAS reviews
2014-06-13	Barracuda FreeAgent GoFlex Home Expansion Desk Buisness BAYNAS	Sample escalation: "Customer wrote letter indicating his displeasure with a drive that failed within 6 weeks. Customer also indicates that flyer included with replacement, offering \$399.00 recovery is insulting. Customer is concerned with time it will take to reload OS, and programs No data loss."	FED_SEAG0086 798	Internal chart on corporate escalations of customer complaints
2014-09-07	BackUp Plus Barracuda	Internal email: " We are struggling a bit to deal with warranty claims in a satisfactory manner at present. . . "	FED_SEAG0093 307	Email between Seagate

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Summary of Seagate's Voluminous Records

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Date	Drive Name	Excerpt or Summary	Bates No.	Description
	FreeAgent GoFlex Desk FreeAgent GoFlex Mac			employees discussing the difficulty keeping up with warranty claims for 3TB drives
2015-02-05 To 2016-05-12	BackUp Plus Barracuda FreeAgent GoFlex Desk FreeAgent GoFlex Mac	<p>Sample Complaint: "I called because my Seagate Barracuda failed (2nd one this year!) and I asked about which Seatools to use, DOS or Windows. He gave me the correct answer. the reason I hesitate to recommend Seagate is because of the high failure rate of these drives. I spent way too much time recovering from this. I bought a WD black to replace this failed drive. I invite your comments back."</p> <p>Sample Complaint: "I got an ST3000DM001 for Christmas a few years ago. It sat in a drawer for two years until I finally got around to use it in a desktop I built. It lasted 3 whole months. Because the warranty was only two years, Seagate offered to do nothing. And then when I looked at backblaze.com. I come to find out that Seagate had sold me the worst 3TB hard drive on the market with an insane failure rate. I will NEVER buy a seagate drive again and I drive hardware decisions for millions of dollars. This is when an experience in my personal life will have an impact on how I make business decisions. Well done Seagate. How you can maintain a warranty policy with a 30% plus failure rate is just dishonest."</p>	FED_SEAG0090 931	Internal chart on direct complaints from customers
2015-03-20 to 2016-05-20	ST3000DM001	Sample Complaint: "Enclosed, please find 3 ST3000DM001 3TB hard drives. All have failed and caused catastrophic data loss in the course of the last 2 years. 2 of these drives have been sent back and replaced with 'Certified Repaired HDD' only to fail again. 2 of these drives were also	FED_SEAG0090 915	Internal chart on direct complaints

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Date	Drive Name	Excerpt or Summary	Bates No.	Description
		<p>part of a RAID-1 pair, which failed its intended purpose of redundant backup when both drives died the same week. There are more failures to speak of on my site alone, but I've chunked the various older drives. I am the CTO at Guerin College Prep and have worked in the technology industry for the last 16 years. I have given up on your company. I am not a sole victim of your abysmal drive failure rate. I have had several friends who have purchased the same model drive, and ALL of them have had MULTIPLE drive failures over the years, with similar stories to tell. All have had drive failures, loss, had them 'repaired,' only to have them fail again. I'm not alone, as you know. Stories of this drive model failures are abound. https://www.backblaze.com/blog/3tb-hard-drive-failure/http://www.extremetech.com/computing/203478-backblaze-pulls-3tb-seagate-ssds-from-service-details-post-mortem-failure-rates http://arstechnica.com/civis/viewtopic.php?f=2&t=1286115</p> <p>It's an embarrassment that a company I advocated for years has had this failure rate, and it's a mystery there's no class action lawsuit against your company from it. I will never purchase Seagate again. I will always choose western digital or Hitachi and advocate my other friends in the industry do the same. I hope there's something you can do to remedy this issue, at least for myself and make it right. And please DO NOT send me another ST3000DM001."</p>		from customers
2015-03-15	ST3000DM001		FED_SEAG0094984	Internal Seagate document comparing 1 star reviews for products; ST3000DM001 has most

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Date	Drive Name	Excerpt or Summary	Bates No.	Description																																																		
		<div><p>Top 1 Star Issues Combined</p><table><thead><tr><th>Issue</th><th>Frequency</th></tr></thead><tbody><tr><td>Reliability/Failure</td><td>121</td></tr><tr><td>DOA</td><td>40</td></tr><tr><td>Speed/Slow</td><td>23</td></tr><tr><td>Non Seagate Issue</td><td>18</td></tr><tr><td>Bad Sectors</td><td>14</td></tr><tr><td>Full Capacity not Accessible</td><td>12</td></tr><tr><td>Corrupt</td><td>11</td></tr><tr><td>OS Issue</td><td>10</td></tr><tr><td>Data Corruption</td><td>4</td></tr><tr><td>Quality</td><td>4</td></tr><tr><td>Warranty Certified Repaired</td><td>4</td></tr><tr><td>Third Party Non Seagate Issue</td><td>4</td></tr><tr><td>Clicking</td><td>3</td></tr><tr><td>OEM Drive</td><td>3</td></tr><tr><td>Corrupt OS</td><td>2</td></tr><tr><td>Compatibility Issue</td><td>2</td></tr><tr><td>Warranty Issue/BadLog</td><td>2</td></tr><tr><td>Vibration / Noise</td><td>2</td></tr><tr><td>Bad Smell</td><td>2</td></tr><tr><td>Support Complaint/Issue</td><td>2</td></tr><tr><td>Capacity Issue</td><td>2</td></tr><tr><td>Mounting Holes</td><td>2</td></tr><tr><td>Offline/Failure</td><td>2</td></tr><tr><td>Total Rv</td><td>1</td></tr></tbody></table></div>	Issue	Frequency	Reliability/Failure	121	DOA	40	Speed/Slow	23	Non Seagate Issue	18	Bad Sectors	14	Full Capacity not Accessible	12	Corrupt	11	OS Issue	10	Data Corruption	4	Quality	4	Warranty Certified Repaired	4	Third Party Non Seagate Issue	4	Clicking	3	OEM Drive	3	Corrupt OS	2	Compatibility Issue	2	Warranty Issue/BadLog	2	Vibration / Noise	2	Bad Smell	2	Support Complaint/Issue	2	Capacity Issue	2	Mounting Holes	2	Offline/Failure	2	Total Rv	1		negative reviews
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Date	Drive Name	Excerpt or Summary	Bates No.	Description																																																																																
		<div>1 Star by Model 6 Months</div> <table><thead><tr><th>Model</th><th>Count</th></tr></thead><tbody><tr><td>ST3000DM001</td><td>84</td></tr><tr><td>ST1000LM014</td><td>43</td></tr><tr><td>ST4000DM001</td><td>39</td></tr><tr><td>ST2000LM003</td><td>21</td></tr><tr><td>ST2000LM000</td><td>14</td></tr><tr><td>ST3000LM000</td><td>13</td></tr><tr><td>ST3000LM000</td><td>12</td></tr><tr><td>ST3000LM000</td><td>10</td></tr><tr><td>ST3000LM000</td><td>8</td></tr><tr><td>ST3000LM000</td><td>6</td></tr><tr><td>ST3000LM000</td><td>5</td></tr><tr><td>ST3000LM000</td><td>5</td></tr><tr><td>ST3000LM000</td><td>5</td></tr><tr><td>ST3000LM000</td><td>4</td></tr><tr><td>ST3000LM000</td><td>4</td></tr><tr><td>ST3000LM000</td><td>4</td></tr><tr><td>ST3000LM000</td><td>4</td></tr><tr><td>ST3000LM000</td><td>4</td></tr><tr><td>ST3000LM000</td><td>4</td></tr><tr><td>ST3000LM000</td><td>4</td></tr><tr><td>ST3000LM000</td><td>3</td></tr><tr><td>ST3000LM000</td><td>3</td></tr><tr><td>ST3000LM000</td><td>3</td></tr><tr><td>ST3000LM000</td><td>3</td></tr><tr><td>ST3000LM000</td><td>2</td></tr><tr><td>ST3000LM000</td><td>2</td></tr><tr><td>ST3000LM000</td><td>2</td></tr><tr><td>ST3000LM000</td><td>2</td></tr><tr><td>ST3000LM000</td><td>1</td></tr><tr><td>ST3000LM000</td><td>1</td></tr><tr><td>ST3000LM000</td><td>1</td></tr><tr><td>ST3000LM000</td><td>1</td></tr><tr><td>ST3000LM000</td><td>1</td></tr><tr><td>ST3000LM000</td><td>1</td></tr><tr><td>ST3000LM000</td><td>1</td></tr><tr><td>ST3000LM000</td><td>1</td></tr><tr><td>ST3000LM000</td><td>1</td></tr><tr><td>ST3000LM000</td><td>1</td></tr><tr><td>ST3000LM000</td><td>1</td></tr></tbody></table>	Model	Count	ST3000DM001	84	ST1000LM014	43	ST4000DM001	39	ST2000LM003	21	ST2000LM000	14	ST3000LM000	13	ST3000LM000	12	ST3000LM000	10	ST3000LM000	8	ST3000LM000	6	ST3000LM000	5	ST3000LM000	5	ST3000LM000	5	ST3000LM000	4	ST3000LM000	4	ST3000LM000	4	ST3000LM000	4	ST3000LM000	4	ST3000LM000	4	ST3000LM000	4	ST3000LM000	3	ST3000LM000	3	ST3000LM000	3	ST3000LM000	3	ST3000LM000	2	ST3000LM000	2	ST3000LM000	2	ST3000LM000	2	ST3000LM000	1	ST3000LM000	1	ST3000LM000	1	ST3000LM000	1	ST3000LM000	1	ST3000LM000	1	ST3000LM000	1	ST3000LM000	1	ST3000LM000	1	ST3000LM000	1	ST3000LM000	1		
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2015-06-01	BackUp Plus Barracuda FreeAgent GoFlex Desk FreeAgent GoFlex Mac	Sample Complaint: “The phone call was based on a warranty of a 3tb Hard Drive. This drive was when Seagate changed the warranty down to 1 year and i understand why because the batch of those drives was terrible. Very high failure rate. The warranty used to be 5 years, then went to 3 years and for these drives went to 1 years. if it still had the standard drive warranty of 3 years it would have still been under warranty.”	FED_SEAG0090 938	Seagate spreadsheet detailing direct customer complaints																																																																																
2015-07-24	ST3000DM001 and RAID	Internal email about customer complaints: “Total of 102 cases starting on 1/1/2015 mentioning ST3000DM001 and RAID. ~5800 cases starting	FED_SEAG0085 843	Internal email about																																																																																

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		1/1/2015 mentioning ST3000DM001. Thus, 1.5% of calls we’ve received since 1 Jan are about ST3000DM001, and 1.8% of those calls are about RAID.		customer complaints																																										
2015-09-25	Barracuda	<p>Internal presentation on “dearth of 1-star reviews” for Grenada 3 TB. Seagate performs a failure analysis and confirms “a mix of head-related failures & contamination” failure analysis also showed “Lube Depletion issue”</p> <table><caption>Amazon Overall Percentage Star Rating</caption><thead><tr><th>Drive Model</th><th>1 star</th><th>2 star</th><th>3 star</th><th>4 star</th><th>5 star</th></tr></thead><tbody><tr><td>STX2TB</td><td>16%</td><td>4%</td><td>2%</td><td>8%</td><td>70%</td></tr><tr><td>WD2TB</td><td>6%</td><td>4%</td><td>2%</td><td>8%</td><td>71%</td></tr><tr><td>STX3TB</td><td>23%</td><td>6%</td><td>4%</td><td>2%</td><td>65%</td></tr><tr><td>WD3TB</td><td>9%</td><td>3%</td><td>4%</td><td>16%</td><td>68%</td></tr><tr><td>STX4TB</td><td>12%</td><td>4%</td><td>2%</td><td>8%</td><td>74%</td></tr><tr><td>WD4TB</td><td>13%</td><td>2%</td><td>1%</td><td>8%</td><td>76%</td></tr></tbody></table>	Drive Model	1 star	2 star	3 star	4 star	5 star	STX2TB	16%	4%	2%	8%	70%	WD2TB	6%	4%	2%	8%	71%	STX3TB	23%	6%	4%	2%	65%	WD3TB	9%	3%	4%	16%	68%	STX4TB	12%	4%	2%	8%	74%	WD4TB	13%	2%	1%	8%	76%	FED_SEAG0084 417	Seagate Presentation on the “dearth of 1-star reviews”
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		<div><p>NewEgg Overall Percentage Star Rating</p><table><thead><tr><th>Drive Model</th><th>1 star</th><th>2 star</th><th>3 star</th><th>4 star</th><th>5 star</th><th>Overall Avg</th></tr></thead><tbody><tr><td>STX2TB</td><td>31%</td><td>0.08</td><td>0.07</td><td>0.12</td><td>0.44</td><td>0.12</td></tr><tr><td>WD2TB</td><td>21%</td><td>2%</td><td>3%</td><td>20%</td><td>53%</td><td>0.11</td></tr><tr><td>STX3TB</td><td>34%</td><td>0.12</td><td>0.09</td><td>0.11</td><td>0.34</td><td>0.11</td></tr><tr><td>WD3TB</td><td>32%</td><td>8%</td><td>9%</td><td>12%</td><td>38%</td><td>0.16</td></tr><tr><td>STX4TB</td><td>25%</td><td>0.06</td><td>0.06</td><td>0.16</td><td>0.46</td><td>0.16</td></tr><tr><td>WD4TB</td><td>25%</td><td>5%</td><td>8%</td><td>18%</td><td>44%</td><td>0.18</td></tr></tbody></table></div>	Drive Model	1 star	2 star	3 star	4 star	5 star	Overall Avg	STX2TB	31%	0.08	0.07	0.12	0.44	0.12	WD2TB	21%	2%	3%	20%	53%	0.11	STX3TB	34%	0.12	0.09	0.11	0.34	0.11	WD3TB	32%	8%	9%	12%	38%	0.16	STX4TB	25%	0.06	0.06	0.16	0.46	0.16	WD4TB	25%	5%	8%	18%	44%	0.18		
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WD4TB	25%	5%	8%	18%	44%	0.18																																															
2016-01-28	ST3000DM001	<p>Tito B: Hello. Thank you for contacting Seagate on Newegg.com. My name is Tito. How may I be of assistance?</p> <p>Visitor: Hi I was wondering how long the manufacturers warranty is on the seagate st3000dm001 drive is? I want to get it, but there are lots of reviews that say the drives die or arrive doa and its putting me off a bit</p> <p>Tito B: Desktop HDDs have a 2-year manufacturers warranty.</p> <p>Visitor: ok thanks</p> <p>Tito B: I am sorry the reviews are putting you off a bit. But I would be happy to answer any inquiries you have about this unit or other Seagate drives.</p>	FED_SEAG0095597	Internal Seagate spreadsheet recording 496 customer interactions on Newegg between 1/1/16 and 3/23/16																																																	

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Date	Drive Name	Excerpt or Summary	Bates No.	Description
2016-02-24	ST3000DM001	<p>Tito B: Hello. Thank you for contacting Seagate on Newegg.com. My name is Tito. How may I be of assistance?</p> <p>Visitor: Hello Tito, I'm trying to figure out the difference between 3 Seagate HDDs and which one would be best for my needs.</p> <p>Visitor: The part numbers are:</p> <p>Visitor: HDD ST3000DM002</p> <p>Visitor: ST3000DM001</p> <p>Visitor: and STBD3000100</p> <p>Tito B: There is no real difference between these three model numbers. The first two model numbers refer to the bare drive version of the Desktop HDD. One primarily sold in the US and the other in another region of the world. The STBD3000100 is the retail kit version of the drive. All these HDDs have the same features and functionality.</p> <p>Visitor: So there's no difference between the bare drive and the retail kit?</p> <p>Tito B: The only difference between the bare drive and retail kits is that the retail kits come with installation instructions, information for the free software for cloning. The drive itself is the same.</p> <p>Visitor: Got it. Thank you!</p>	FED_SEAG0095597	Internal Seagate spreadsheet recording 496 customer interactions on Newegg between 1/1/16 and 3/23/16
2016-02-27 to 2016-03-30	Backup Plus Desktop Expansion Desktop	<p>Sample Complaint Backup Plus Desktop– “Used it four times and it died. Lost the ..., Used it four times and it died. Lost the data because the warranty does not cover data recovery (\$600 extra). If I return the hard drive, Seagate would replace it but why would I trust a new drive with my data. I'm never buying another seagate product.”</p> <p>Sample Complaint – Expansion Desktop “ Buyer Beware!!!!, I have always heard good things about Seagate, then I bought this drive. It installed nicely and performed well enough for the first few weeks. Just long enough for me to move my small business accounting onto it along with a bunch of historical records. Then one day, my computer could no longer find the drive. I contacted customer support and they walked me</p>	FED_SEAG0076421	Internal Seagate document tracking negative reviews Amazon, Best Buy, and Google Play

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		through a few things before informing me that my drive was "clipped" and there was nothing that I could do but, maybe, their data recovery services could salvage my data. I contacted their data recovery services and they quoted me \$700 (\$49 Engagement Fee and \$650 Recovery Fee). This is worse than a waste of your money. It is a trap! Buyer beware!"		
2016-03-10	N/A	Internal discussion at Seagate regarding information on website about drives: "Most of the feedback on the specs tab that's in production today trends more to the right. That doesn't mean anyone is wrong or right. More specifically, the feedback we get is that it's complicated, hides too much information , and there's lots of redundant information so its difficult to see what is the difference between products. "	FED_SEAG0084 392	Internal discussion at Seagate regarding information on website about drives
2016-05-16		Zach G: Hello. Thank you for contacting Seagate on Newegg.com. My name is Zach. How may I be of assistance? Visitor: how long is the warrnty since drive rarley last Zach G: The warranty on the NAS HDD is 3 years, as indicated under Warranty & Returns Visitor: can I ask why seagate drive seem to have a high failure rate? Zach G: I would not have an answer for that as we have not seen that to be the case. Visitor: of course you are gonna say that Zach G: When used in the environment they are designed for, our drives have shown to have failure rates consistent with any other.	FED_SEAG0093 285	Seagate document recording customer service chats with potential customers
2016-09-01	BackUp Plus Barracuda FreeAgent GoFlex Desk FreeAgent GoFlex Mac	Sample Complaint - BackUp Plus: "Support is fine. It is the reliability of the drives and the lack of published failure rates that is the problem. In an ideal world the drives would have a predictable failure interval so that a planned replacement or better a warning that the drive is Bout to fail."	FED_SEAG0090 943	Seagate spreadsheet detailing direct customer complaints

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2016-09-12	BackUp Plus Desk BackUp Plus Mac FreeAgent GoFlex Home	Sample complaint: "First off a hard drive should not fail within first two months of ownership. Very upset with losing drive content. I have a protective case and all. HD recovery has been standard with other many factors that I used in past within time limits. Will not recommend product based on this. Bought this while on deployment and had pictures that I am not able to recover. Recovery for this drive was going to cost me well more than the drive which is ridiculous. Very upset with product and inability to serve customer	FED_SEA0090903	Seagate spreadsheet detailing direct customer complaints
2016-09-13	Barracuda BackUp Plus Mac FreeAgent GoFlex Home FreeAgent GoFlex Desk Business 1BAY NAS Business 2BAY NAS Buisness 4BAY NAS	<p>Sample Complaint - BackUp Plus Mac : "Nothing. Your product failed after I used it once, if it even backed up once effectively. Apple Care could not help us to have the Mac recognize your product. I spent 4 hours on a day off trying to resolve this issue, and no one can replace that time for me, and your policy is not to return my money. I now have a different product that continues to work reliably. When I looked online, there were multiple concerns about the reliability about the Seagate backup drive, and I just don't have faith in your product anymore. My daughter has one that so far seems to be working ok, but I am thinking about replacing that as well, with the device we have now"</p> <p>Sample Complaint – Buisnees 4BAY NAS: "This is the second failure of the product resulting in the loss of data. Better reliability of the product."</p> <p>Sample Complaint – BackUp Plus Mac: "My relatively new external hard drive appears to have failed. Some months back I loaded the files. It worked a few times when I needed to access them and then suddenly stopped working. So now I cannot access any of it - except, according to the agent, at the cost of undetermined hundreds of dollars. Tried a new cord, but to no avail. So, yes, I can hardly recommend the product. Perhaps I was naive in presuming it would work. No one warned me that I should buy two or three instead of just one, for instance. -Jim"</p>	FED_SEAG0090915	Seagate spreadsheet detailing direct customer complaints

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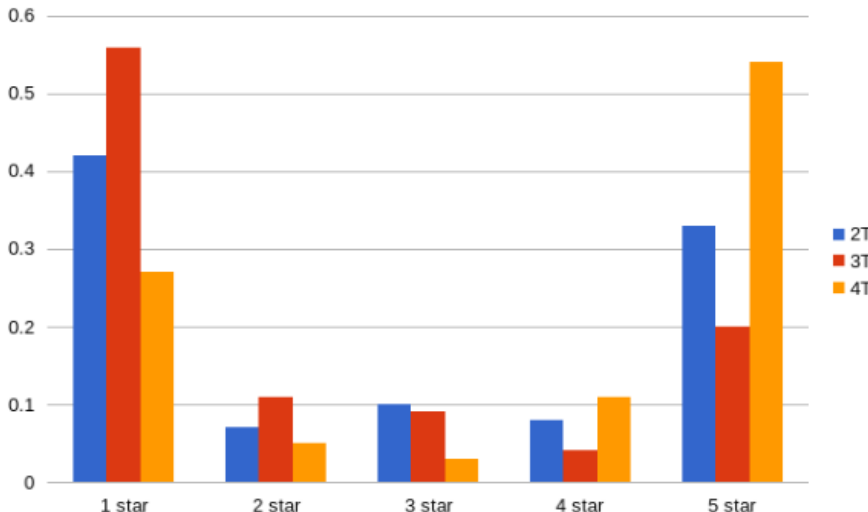
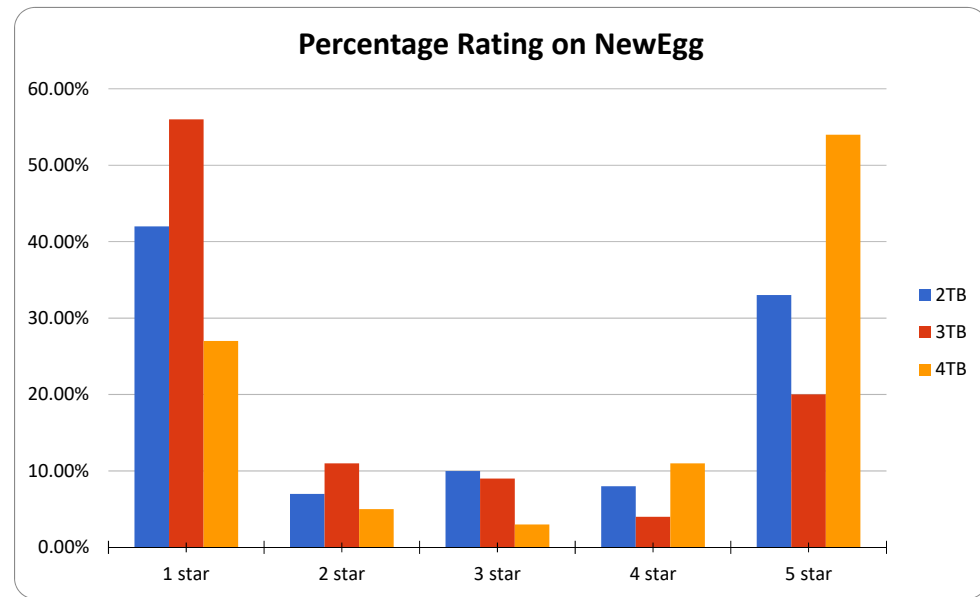
Date	Drive Name	Excerpt or Summary				Bates No.	Description
2016-10-11		STX Last 6 months				FED_SEAG0090966	Seagate spreadsheet summarizing all Amazon reviews for 2TB, 3TB and 4TB drives
			2TB	3TB	4TB		
		1 star	42.00%	56.00%	27.00%		
		2 star	7.00%	11.00%	5.00%		
		3 star	10.00%	9.00%	3.00%		
		4 star	8.00%	4.00%	11.00%		
		5 star	33.00%	20.00%	54.00%		
		Total	83	133	37		
							

EXHIBIT 74

No image available for this record.

STX Last 6 months

	2TB	3TB	4TB
1 star	42.00%	56.00%	27.00%
2 star	7.00%	11.00%	5.00%
3 star	10.00%	9.00%	3.00%
4 star	8.00%	4.00%	11.00%
5 star	33.00%	20.00%	54.00%
Total	83	133	37



FED_SEAG0090966**Metadata**

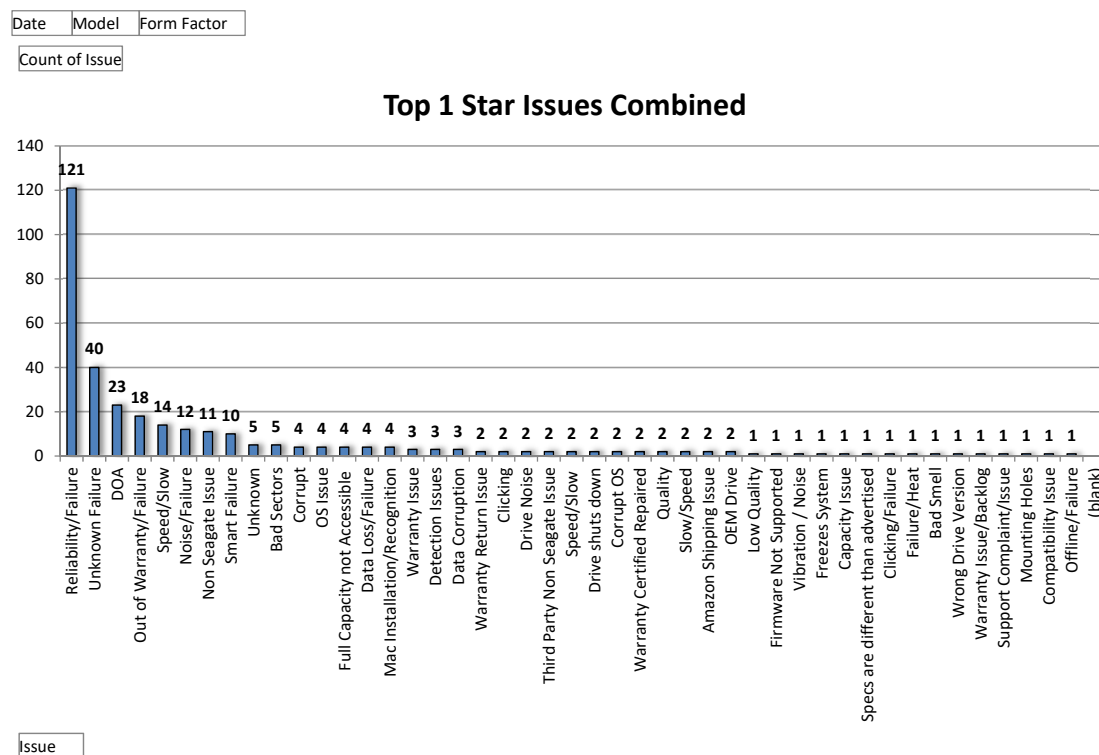
Attach Counts	0	ORIGINAL
Confidentiality	Highly Confidential - Attorneys' Eyes Only	USER
Custodian	Sterling_Ronald	ORIGINAL
Custodian Other	Sterling_Ronald	ORIGINAL
DATECREATED	10/11/2016	ORIGINAL
DATELASTMOD	10/3/2016	ORIGINAL
DOEXT	xlsx	ORIGINAL
DOCTYPE	MS Excel 2007-2010 Spreadsheet (Open XM	ORIGINAL
FED_BEGATTACH	FED_SEAG0090966	ORIGINAL
FED_ENDATTACH	FED_SEAG0090966	ORIGINAL
FileName	STX NewEgg 1 Star Review Comments for last 6 mon_1p9OOILz0vW2fxChBzXaZDcmWdDFtQxq6REaGocTxYQw.xlsx	ORIGINAL
FILESIZE	75620	ORIGINAL
LastAccessDate	10/11/2016 12:00 AM	ORIGINAL
LastAccessedTime	7:24 AM	ORIGINAL
MD5 Hash	04E0A5C9243BAD7D38BB6BB7ECF9D663	ORIGINAL
OrgFolder	\\Sterling_Ronald\\Ronald_Sterling_Drive_0\\	ORIGINAL
RecordType	E-DOC	ORIGINAL
Relativity Native Time Zone Offset	-8.00	ORIGINAL
TIMECREATED	12:24 AM	ORIGINAL
TimeLastMod	11:16 AM	ORIGINAL

EXHIBIT 75

No image available for this record.

Date	(All)	
Model	(All)	Select Model Here
Form Factor	(All)	Select Form Factor Here

Row Labels	Count of Issue
Reliability/Failure	121
Unknown Failure	40
DOA	23
Out of Warranty/Failure	18
Speed/Slow	14
Noise/Failure	12
Non Seagate Issue	11
Smart Failure	10
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Bad Sectors	5
Corrupt	4
OS Issue	4
Full Capacity not Accessible	4
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Warranty Issue	3
Detection Issues	3
Data Corruption	3
Warranty Return Issue	2
Clicking	2
Drive Noise	2
Third Party Non Seagate Issue	2
Speed/Slow	2
Drive shuts down	2
Corrupt OS	2
Warranty Certified Repaired	2
Quality	2
Slow/Speed	2
Amazon Shipping Issue	2
OEM Drive	2
Low Quality	1
Firmware Not Supported	1
Vibration / Noise	1
Freezes System	1
Capacity Issue	1
Specs are different than advertised	1
Clicking/Failure	1
Failure/Heat	1
Bad Smell	1
Wrong Drive Version	1
Warranty Issue/Backlog	1
Support Complaint/Issue	1
Mounting Holes	1
Compatibility Issue	1
Offline/Failure	1
(blank)	
Grand Total	327



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EXHIBIT 77

From: Karl J Schweiss <karl.j.schweiss@seagate.com>
Sent: Monday, January 26, 2015 10:01 AM
To: Keith R Myers <keith.r.myers@seagate.com>
Subject: Re: URGENT: Siemens: Product Manuals - new Reliability-paragraph questions (100686584 Rev K)
Attach: 100686584L4.pdf

Keith,

OK.

8760 changed to 2400 on pages 9, 11 & 20.

Let me know if this is OK?

Best regards,
Karl J. Schweiss
Sr. Tech. Writer
8-324-3290 office (Seatel)
405-324-3290 office
405-226-2325 cell

On Mon, Jan 26, 2015 at 9:39 AM, Karl J Schweiss <karl.j.schweiss@seagate.com> wrote:

Keith,

Attached L3 with the POH changed to 8760 on pgs 9 & 20.

Best regards,
Karl J. Schweiss
Sr. Tech. Writer
8-324-3290 office (Seatel)
~~405-324-3290 office~~
~~405-226-2325 cell~~

On Fri, Jan 23, 2015 at 10:49 AM, Karl J Schweiss <karl.j.schweiss@seagate.com> wrote:

Keith,

Let me know how this looks & what you think about the AFR section text I sent earlier.

Best regards,
Karl J. Schweiss
Sr. Tech. Writer
8-324-3290 office (Seatel)
~~405-324-3290 office~~
~~405-226-2325 cell~~

On Fri, Jan 23, 2015 at 10:25 AM, Karl J Schweiss <karl.j.schweiss@seagate.com> wrote:

Keith,

Here is a Reli section from a Galaxy manual.

2.10.1 Annualized Failure Rate (AFR)

The product shall achieve an Annualized Failure Rate (AFR) of <1.0% when operated in an environment of ambient air temperatures of 25°C. Operation at temperatures outside the specifications in Section 2.9.1 may increase the product.

AFR specifications are based on the following assumptions for desktop personal computer environments:

- o 2,400 power-on-hours per year.
- o 10,000 average motor start/stop cycles per year.
- o Operations at nominal voltages.
- o Temperatures outside the specifications in Section 2.7 may reduce the product reliability.
- o Normal I/O duty cycle for desktop personal computers. Operation at excessive I/O duty cycle may degrade product reliability.

The desktop personal computer environment of power-on-hours, temperature, and I/O duty cycle affect the product AFR. The AFR

will be degraded if used in an enterprise application

I took out all the MTBF references.
Would this verbiage work the the GrenadaBP PM?

Best regards,
Karl J. Schweiss
Sr. Tech. Writer
8-324-3290 office (Seatel)
~~405-324-3290 office~~
~~405-226-2325 cell~~

On Thu, Jan 22, 2015 at 10:22 AM, Karl J Schweiss <karl.j.schweiss@seagate.com> wrote:
Keith,

I have attached the GrenadaBP PM Rev L (Draft 1) for your review.

Please note the red text on page 20. Not certain if all would apply or if stated accurately for GrenadaBP.

I added a Case Temperature note on page 17, let me know if that is sufficient.

You'll note the new logo on front & back, and new page numbering have been applied as well.

Look forward to any edits that may be needed.

Best regards,
Karl J. Schweiss
Sr. Tech. Writer
8-324-3290 office (Seatel)
~~405-324-3290 office~~
~~405-226-2325 cell~~

On Thu, Jan 22, 2015 at 9:37 AM, Karl J Schweiss <karl.j.schweiss@seagate.com> wrote:
Keith,

I'll edit the Mechanical Drawing to clean it up.

I thought I would share with you how this issue was handled in ESG Constellation ES.3 SATA PM.

In Table 2 for Rated Workload & AFR we have:

Nonrecoverable read errors§	1 sector per 10 ¹⁵ bits read§
Annualized Failure Rate (AFR)§	0.44% based on 8760 POH§
Maximum Rated Workload§	Maximum rate of <550TB/year§ Workloads exceeding the annualized rate may degrade the drive MTEF and impact product reliability. The Annualized Workload Rate is in units of TB per year, or TB per 8760 power on hours. Workload Rate = TB transferred * (8760 / recorded power on hours) §
Warranty§	To determine the warranty for a specific drive, use a web browser to access the following web page: (http://www.seagate.com/support/warranty-and-replacements/) § From this page, click on the "Check to see if the drive is under Warranty" link. The following are required to be provided: the drive serial number, model number (or part number) and country of purchase. The system will display the warranty information for the drive. §

For Case temperature we have:

2.7.1 Temperature

a.) Operating

The drive meets the operating specifications over a 41°F to 140°F (5°C to 60°C) drive case temperature range with a maximum temperature gradient of 36°F (20°C) per hour.

The maximum allowable drive case temperature is 60°C. See Figure 9 for HDA case temperature measurement location

The MTBF specification for the drive assumes the operating environment is designed to maintain nominal case temperature. The rated MTBF is based upon a sustained case temperature of 104°F (40°C). Occasional excursions in operating temperature between the rated MTBF temperature and the maximum drive operating case temperature may occur without impact to the rated MTBF temperature. However, continual or sustained operation at case temperatures beyond the rated MTBF temperature will degrade the drive MTBF and reduce product reliability.

Air flow may be required to achieve consistent nominal case temperature values (see Section 3.4). To confirm that the required cooling is provided for the electronics and HDA, place the drive in its final mechanical configuration, and perform random write/read operations. After the temperatures stabilize, measure the case temperature of the drive.

And for Reliability we have:

2.11) Reliability

2.11.1) Annualized Failure Rate (AFR) and Mean Time Between Failures (MTBF)

The production disk drive shall achieve an annualized failure-rate of 0.44% (MTBF of 2,000,000 hours) over a 5 year service life when used in Enterprise Storage field conditions as limited by the following:

- > 8760 power-on-hours per year.
- > HDA temperature as reported by the drive <= 40°C
- > Ambient wet bulb temp <= 26°C
- > Typical workload
- > The AFR (MTBF) is a population statistic not relevant to individual units
- > ANSI/ISA S71.04-2013 G2 classification levels and dust contamination to ISO 14644-1 Class 8 standards (as measured at the device)

The MTBF specification for the drive assumes the operating environment is designed to maintain nominal drive temperature and humidity. Occasional excursions in operating conditions between the rated MTBF conditions and the maximum drive operating conditions may occur without significant impact to the rated MTBF. However continual or sustained operation beyond the rated MTBF conditions will degrade the drive MTBF and reduce product reliability.

Nonrecoverable Read Errors	1 per 10 ¹⁵ bits read, max
Load/unload cycles	600,000 cycles
Maximum Rated Workload	Maximum rate of <550TB/year Workloads exceeding the annualized rate may degrade the drive MTBF and impact product reliability. The Annualized Workload Rate is in units of TB per year, or TB per 8760 power on hours. Workload Rate = TB transferred * (8760 / recorded power on hours).
Warranty	To determine the warranty for a specific drive, use a web browser to access the following web page: http://www.seagate.com/support/warranty-and-replacements/ . From this page, click on the "Check to see if the drive is under Warranty" link. The following are required to be provided: the drive serial number, model number (or part number) and country of purchase. The system will display the warranty information for the drive.
Preventive Maintenance	None required.

Thought this might be of some help in determining how to proceed with the GrenadaBP update.

Let me know if something like these examples from Const ES.3 SATA would work to resolve the issues Siemens pointed out.

Best regards,
Karl J. Schweiss
Sr. Tech. Writer
8-324-3290 office (Seatel)
405-324-3290 office
405-226-2325 cell

On Wed, Jan 21, 2015 at 4:04 PM, Keith R Myers <keith.r.myers@seagate.com> wrote:

Regards,

Keith Myers
Seagate Technology
Program Application Engineer
(720) 684-2065

----- Forwarded message -----

From: Michael A Sandoval <michael.a.sandoval@seagate.com>
Date: Wed, Jan 21, 2015 at 1:42 PM
Subject: Fwd: URGENT: Siemens: Product Manuals - new Reliability-paragraph questions (100686584 Rev K)
To: Keith R Myers <keith.r.myers@seagate.com>

Hi Keith,

Can you please forward this to whoever can do this? Looks like there are 4 items that Siemens when they went through GBP2 PM.
Thanks,
Mike

----- Forwarded message -----

From: Michael A Sandoval <michael.a.sandoval@seagate.com>
Date: Fri, Jan 16, 2015 at 10:11 AM
Subject: Re: URGENT: Siemens: Product Manuals - new Reliability-paragraph questions (100686584 Rev K)
To: Keith R Myers <keith.r.myers@seagate.com>, Steve A Kaufman <steve.a.kaufman@seagate.com>

Cc: Shawn P Bratt <shawn.p.bratt@seagate.com>

Hi Keith,

Will you address the other issues brought up by Siemens about Seagate PM's? Thanks!

Steve,

Thanks for your help!

Mike

On Fri, Jan 16, 2015 at 9:46 AM, Steve A Kaufman <steve.a.kaufman@seagate.com> wrote:

Hi Keith,

We need to go and update the Desktop HDD product manuals to include AFR spec < 1%.

Let me know if you have any questions.

Thanks Sir!

----- Forwarded message -----

From: **Michael A Sandoval** <michael.a.sandoval@seagate.com>

Date: Fri, Jan 16, 2015 at 9:35 AM

Subject: Fwd: URGENT: Siemens: Product Manuals - new Reliability-paragraph questions (100686584 Rev K)

To: Steve A Kaufman <steve.a.kaufman@seagate.com>

Hi Steve,

Who do I talk to about these issues in Seagate Product Manuals?

Mike

----- Forwarded message -----

From: **Hans Juergen Binner** <hansjuergen.binner@seagate.com>

Date: Fri, Jan 16, 2015 at 1:05 AM

Subject: URGENT: Siemens: Product Manuals - new Reliability-paragraph questions (100686584 Rev K)

To: Michael A Sandoval <michael.a.sandoval@seagate.com>

Cc: Michael C Miller <michael.c.miller@seagate.com>

Hello Mike,

please find below some feedback and questions from Siemens regarding our product manuals:

(example here is the Desktop HDD product manual - GrenadaBP2 Product Manual 100686584_Rev K.pdf

1) AFR specification missing

-> the product manual references an AFR specification - but there is NO AFR specification in the product manual

-> is the AFR specification missing or is there any additional document, which provides the corresponding specification?

2) Reliability Section missing

-> in previous product manuals there was a reliability section in the product manual, which is now completely missing

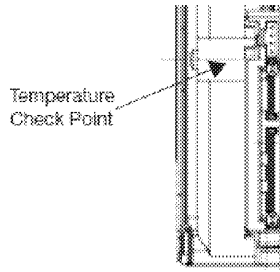
Rated workload	Average rate of <55TB/year. The AFR specification for the drive assumes the I/O workload does not exceed the average annualized workload rate limit of 55TB/year. Workloads exceeding the annualized rate may degrade the drive AFR and impact product reliability. The average annualized workload rate limit is in units of TB per year, or TB per 8760 power-on hours. Workload rate limit = TB transferred x (8760/recorded power-on hours).
----------------	--

3) Case temperature - no max case temperature

-> there is no information about the max case temperature. The temperature check point is shown in the product manual, but the corresponding max case temperature is not listed (any more.)

-> previously there was the following reference "Actual drive case temperature should not exceed 69°C (156°F) within the operating ambient conditions."

-> is this still valid or what is the current definition for the measurement on the temperature check point?



(Picture is taken from the RevJ Version of doc 100686584)

4) The picture of the temperature check point - no clear reading any more

-> In Rev K of 100686584 there are two imprints for the temperature check point and the references are interlaced - they can not be seen/read any more clearly - please see page 20 of 100686584 RevK

Could you please help with these questions?

Thank you.

Best regards,
Hansjuergen

Regards,

Mike Sandoval
Seagate Technologies
Phone: 720-684-2048
email: michael.a.sandoval@seagate.com

Steve Kaufman
Seagate Technology
Office: 720-684-3379
Cell: 307-399-1532
steve.a.kaufman@seagate.com

--
Regards,

Mike Sandoval
Seagate Technologies
Phone: 720-684-2048
email: michael.a.sandoval@seagate.com

--
Regards,

Mike Sandoval
Seagate Technologies
Phone: 720-684-2048
email: michael.a.sandoval@seagate.com

|||

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TO	Keith R Myers <keith.r.myers@seagate.com>	ORIGINAL



Product Manual

Seagate[®] Desktop HDD

Standard models

ST3000DM001
ST2000DM001
ST1500DM003
ST1000DM003
ST750DM003
ST500DM002
ST320DM000
ST250DM000

Self-Encryption models

ST3000DM002
ST2000DM002
ST1000DM004

Gen 14
100686584
Rev. L (Draft 4)
January 2015

Document Revision History

Revision	Date	Description of Change
Rev. A	08/19/2011	Initial release.
Rev. B	09/01/2011	Updated decibel specifications, start/stop times; Table 3; mounting drawing.
Rev. C	10/20/2011	Updated voltage tolerance specifications.
Rev. D	01/17/2012	Corrected Table 1 (Altitude, operating) specification and Table 5 (Idle2).
Rev. E	06/11/2012	Updated Index.
Rev. F	09/05/2012	Added 2.5A spin-up code option (Table 1 and Table 2); page 17.
Rev. G	10/01/2012	Updated Table 1 and Table 2 with rated workload information. Updated DC power requirements (Tables 1, 3 and 4).
Rev. H	03/21/2014	Revised Rated Workload statement (pages 5 & 7); LP height updated & new mechanical drawings (pages 4, 9 & 20-21); Revised max storage note (page 13)
Rev. J	05/08/2014	Updated product name (pages fc, 2, 19 & 22) and Add metric "mm" values to mechanical drawings. (pages 20-21).
Rev. K	08/28/2014	Add SED models and SED Section 4.0 (pages: fc, 2, 4, 7, 22-23 & 29)
Rev. L (Draft 1)	01/22/2015	Pages: fc, bc, 9, 11, 17, 20, 24-25. (applied new logo, applied latest page numbering convention, add AFR, update Rated Workload, added Case Temp note, add Reliability section & cleaned up Mechanical Drawings)
Rev. L (Draft 2)	01/23/2015	Pages: 9, 11 & 20 (AFR = <1.0%, remove MTBF references & revise AFR Section 2.12.1)
Rev. L (Draft 3)	01/26/2015	Pages: 9 & 20 (see change bars) (AFR POH = 8760)
Rev. L (Draft 4)	01/26/2015	Pages: 9, 11 & 20 (see change bars) (AFR POH = 2400)

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Publication number: 100686584, Rev. L (Draft 4) January 2015

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When referring to drive capacity, one gigabyte, or GB, equals one billion bytes and one terabyte, or TB, equals one trillion bytes. Your computer's operating system may use a different standard of measurement and report a lower capacity. In addition, some of the listed capacity is used for formatting and other functions, and thus will not be available for data storage. Actual quantities will vary based on various factors, including file size, file format, features and application software. Actual data rates may vary depending on operating environment and other factors. The export or re-export of hardware or software containing encryption may be regulated by the U.S. Department of Commerce, Bureau of Industry and Security (for more information, visit www.bis.doc.gov), and controlled for import

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For Seagate OEM and Distribution partner portal, visit: <http://www.seagate.com/partners>

For Seagate reseller portal, visit: <http://www.seagate.com/partners/my-spp-dashboard/>

1.0 Introduction

This manual describes the functional, mechanical and interface specifications for the following:
Seagate® Desktop HDD model drives:

Standard models		Self-Encryption models
ST3000DM001	ST750DM003	ST3000DM002
ST2000DM001	ST500DM002	ST2000DM002
ST1500DM003	ST320DM000	ST1000DM004
ST1000DM003	ST250DM000	

Note

Previous generations of Seagate Self-Encrypting Drive models were called Full Disk Encryption (FDE) models before a differentiation between drive-based encryption and other forms of encryption was necessary.

These drives provide the following key features:

- 7200 RPM spindle speed.
- High instantaneous (burst) data-transfer rates (up to 600MB per second).
- TGMR recording technology provides the drives with increased areal density.
- State-of-the-art cache and on-the-fly error-correction algorithms.
- Native Command Queuing with command ordering to increase performance in demanding applications.
- Full-track multiple-sector transfer capability without local processor intervention.
- Seagate AcuTrac™ servo technology delivers dependable performance, even with hard drive track widths of only 75 nanometers.
- Seagate OptiCache™ technology boosts overall performance by as much as 45% over the previous generation.
- Seagate SmartAlign™ technology provides a simple, transparent migration to Advanced Format 4K sectors
- Quiet operation.
- Compliant with RoHS requirements in China and Europe.
- SeaTools diagnostic software performs a drive self-test that eliminates unnecessary drive returns.
- Support for S.M.A.R.T. drive monitoring and reporting.
- Supports latching SATA cables and connectors.
- Worldwide Name (WWN) capability uniquely identifies the drive.

1.1 About the SATA interface

The Serial ATA (SATA) interface provides several advantages over the traditional (parallel) ATA interface. The primary advantages include:

- Easy installation and configuration with true plug-and-play connectivity. It is not necessary to set any jumpers or other configuration options.
- Thinner and more flexible cabling for improved enclosure airflow and ease of installation.
- Scalability to higher performance levels.

In addition, SATA makes the transition from parallel ATA easy by providing legacy software support. SATA was designed to allow users to install a SATA host adapter and SATA disk drive in the current system and expect all of the existing applications to work as normal.

The SATA interface connects each disk drive in a point-to-point configuration with the SATA host adapter. There is no master/slave relationship with SATA devices like there is with parallel ATA. If two drives are attached on one SATA host adapter, the host operating system views the two devices as if they were both “masters” on two separate ports. This essentially means both drives behave as if they are Device 0 (master) devices.

The SATA host adapter and drive share the function of emulating parallel ATA device behavior to provide backward compatibility with existing host systems and software. The Command and Control Block registers, PIO and DMA data transfers, resets, and interrupts are all emulated.

The SATA host adapter contains a set of registers that shadow the contents of the traditional device registers, referred to as the Shadow Register Block. All SATA devices behave like Device 0 devices. For additional information about how SATA emulates parallel ATA, refer to the “Serial ATA International Organization: Serial ATA Revision 3.0”. The specification can be downloaded from www.sata-io.org.

Note

The host adapter may, optionally, emulate a master/slave environment to host software where two devices on separate SATA ports are represented to host software as a Device 0 (master) and Device 1 (slave) accessed at the same set of host bus addresses. A host adapter that emulates a master/slave environment manages two sets of shadow registers. This is not a typical SATA environment.

2.0 Drive Specifications

Unless otherwise noted, all specifications are measured under ambient conditions, at 25°C, and nominal power. For convenience, the phrases *the drive* and *this drive* are used throughout this manual to indicate the following drive models:

Standard models		Self-Encryption models
ST3000DM001	ST750DM003	ST3000DM002
ST2000DM001	ST500DM002	ST2000DM002
ST1500DM003	ST320DM000	ST1000DM004
ST1000DM003	ST250DM000	

2.1 Specification summary tables

The specifications listed in Table 1 and Table 2 are for quick reference. For details on specification measurement or definition, refer to the appropriate section of this manual.

Table 1 Drive specifications summary for 3TB, 2TB, 1.5TB, 1TB and 750GB models

Drive Specification*	ST3000DM001 & ST3000DM002; ST2000DM001	ST2000DM001 & ST2000DM002; ST1500DM003	ST1000DM003 & ST1000DM004; ST750DM003
Formatted capacity (512 bytes/sector)**	3000GB (3TB); 2000GB (2TB)	2000GB (2TB); 1500GB (1.5TB)	1000GB (1TB); 750GB
Guaranteed sectors	5,860,533,168; 3,907,029,168	3,907,029,168; 2,930,277,168	1,953,525,168; 1,465,149,168
Heads	6	4	2
Disks	3	2	1
Bytes per sector (4K physical emulated at 512-byte sectors)	4096		
Default sectors per track	63		
Default read/write heads	16		
Default cylinders	16,383		
Recording density (max)	1807kFCI		
Track density (avg)	352ktracks/in		
Areal density (avg)	625Gb/in ²		
Spindle speed	7200 RPM		
Internal data transfer rate (max)	2147Mb/s		
Average data rate, read/write (MB/s)	156MB/s		
Maximum sustained data rate, OD read (MB/s)	210MB/s		
I/O data-transfer rate (max)	600MB/s		
Cache buffer	64MB		
Height (max)	26.1mm / 1.028 in		19.98mm / 0.787 in
Width (max)	101.6mm / 4.0 in (± 0.010 in)		101.6mm / 4.0 in (± 0.010 in)
Length (max)	146.99mm / 5.787 in		146.99mm / 5.787 in
Weight (typical)	626g / 1.38 lb	535g / 1.18 lb	400g / 0.88 lb
Average latency	4.16ms		
Power-on to ready (max)	<17.0s		<10.0s
Power-on to ready, 2.5A spin-up code option (typical)	<10.0s		n/a
Standby to ready (max)	<17.0s		<10.0s
Average seek, read (typical)	<8.5ms typical		
Average seek, write (typical)	<9.5ms typical		
Startup current 12V	2.0A or 2.8A		2.0A

Table 1 Drive specifications summary for 3TB, 2TB, 1.5TB, 1TB and 750GB models (continued)

Drive Specification*	ST3000DM001 & ST3000DM002; ST2000DM001	ST2000DM001 & ST2000DM002; ST1500DM003	ST1000DM003 & ST1000DM004; ST750DM003
Voltage tolerance (including noise)	5V: $\pm 5\%$ 12V: +10% / -7.5%		
Ambient temperature	0° to 60°C (operating) -40° to 70°C (non-operating)		
Temperature gradient	20°C per hour max (operating) 30°C per hour max (non-operating)		
Relative humidity	5% to 95% (operating) 5% to 95% (non-operating)		
Relative humidity gradient (max)	30% per hour		
Wet bulb temperature (max)	37.7°C max (operating) 40.0°C max (non-operating)		
Altitude, operating	-304.8m to 3048m (-1000 ft to 10,000+ ft)		
Altitude, non-operating (below mean sea level, max)	-304.8m to 12,192m (-1000 ft to 40,000+ ft)		
Operational shock (max)	80 Gs at 2ms		
Non-operational shock (max)	300 Gs at 2ms		350 Gs at 2ms
Vibration, operating	2Hz to 22Hz: 0.25 Gs, Limited displacement 22Hz to 350Hz: 0.50 Gs 350Hz to 500Hz: 0.25 Gs		
Vibration, non-operating	5Hz to 22Hz: 3.0 Gs 22Hz to 350Hz: 3.0 Gs 350Hz to 500Hz: 3.0 Gs		
Drive acoustics, sound power Idle***	2.4 bels (typical) 2.6 bels (max)		2.2 bels (typical) 2.4 bels (max)
Seek	2.6 bels (typical) 2.7 bels (max)		2.4 bels (typical) 2.5 bels (max)
Non-recoverable read errors	1 per 10^{14} bits read		
Annualized Failure Rate (AFR)	<1.0% based on 2400 POH		
Maximum Rated workload	Maximum rate of <55TB/year Workloads exceeding the annualized rate may impact product reliability. The Annualized Workload Rate is in units of TB per year, or TB per 2400 power on hours. Workload Rate = TB transferred * (2400 / recorded power on hours).		
Warranty	To determine the warranty for a specific drive, use a web browser to access the following web page: http://www.seagate.com/support/warranty-and-replacements/ . From this page, click on "Check to see if the drive is under Warranty". Users will be asked to provide the drive serial number, model number (or part number) and country of purchase. The system will display the warranty information for the drive.		
Load/Unload cycles (25°C, 50% rel. humidity)	300,000		
Supports Hotplug operation per the Serial ATA Revision 3.2 specification	Yes		

*All specifications above are based on native configurations.

** One GB equals one billion bytes and 1TB equals one trillion bytes when referring to hard drive capacity. Accessible capacity may vary depending on operating environment and formatting.

*** During periods of drive idle, some offline activity may occur according to the S.M.A.R.T. specification, which may increase acoustic and power to operational levels.

Table 2 Drive specifications summary for 500GB, 320GB and 250GB models

Drive Specification*	ST500DM002	ST320DM000	ST250DM000
Formatted capacity**	500GB	320GB	250GB
Guaranteed sectors	976,773,168	625,142,448	488,397,168
Heads	2		1
Disks	1		
Bytes per sector (4K physical emulated at 512-byte sectors)	4096		
Default sectors per track	63		
Default read/write heads	16		
Default cylinders	16,383		
Recording density (max)	1413kb/in		
Track density (avg)	236ktracks/in		
Areal density (avg)	329Gb/in ²		
Spindle speed	7200 RPM		
Internal data transfer rate (max)	1695Mb/s		
Average Data Rate, read/write (MB/s)	125MB/s		
Maximum sustained data transfer rate, OD read	144MB/s		
I/O data-transfer rate (max.)	600MB/s		
Cache buffer	16MB		
Height (max)	19.98mm / 0.787 in		
Width (max)	101.6mm / 4.0 in (± 0.010 in)		
Length (max)	146.99mm / 5.787 in		
Weight (typical)	415g / 0.915 lb		
Average latency	4.16ms		
Power-on to ready (max)	<8.5s		
Standby to ready (max)	<8.5s		
Average seek, read (typical)	<8.5ms (read)		
Average seek, write (typical)	<9.5ms (write)		
Startup current (typical) 12V	2.0A		
Voltage tolerance (including noise)	5V: ±5% 12V: +10% / -7.5%		
Ambient temperature	0° to 60°C (operating) -40° to 70°C (non-operating)		
Temperature gradient	20°C per hour max (operating) 30°C per hour max (non-operating)		
Relative humidity	5% to 95% (operating) 5% to 95% (non-operating)		
Relative humidity gradient (max)	30% per hour		
Wet bulb temperature (max)	37.7°C (operating) 40.0°C (non-operating)		
Altitude, operating	-304.8m to 3048m (-1000 ft to 10,000+ ft)		
Altitude, non-operating (below mean sea level, max)	-304.8m to 12,192m (-1000 ft to 40,000+ ft)		
Operational shock (max)	70 Gs at 2ms		
Non-operational shock (max)	350 Gs at 2ms		
Vibration, operating	2Hz to 22Hz: 0.25 Gs, Limited displacement 22Hz to 350Hz: 0.50 Gs 350Hz to 500Hz: 0.25 Gs		
Vibration, non-operating	5Hz to 22Hz: 3.0 Gs 22Hz to 350Hz: 3.0 Gs 350Hz to 500Hz: 3.0 Gs		
Drive acoustics, sound power			

Table 2 Drive specifications summary for 500GB, 320GB and 250GB models (continued)

Drive Specification*	ST500DM002	ST320DM000	ST250DM000
Idle***		2.2 bels (typical) 2.3 bels (max)	
Seek		2.3 bels (typical) 2.4 bels (max)	
Non-recoverable read errors	1 per 10 ¹⁴ bits read		
Annualized Failure Rate (AFR)	<1.0% based on 2400 POH		
Maximum Rated workload	Maximum rate of <55TB/year Workloads exceeding the annualized rate may impact product reliability. The Annualized Workload Rate is in units of TB per year, or TB per 2400 power on hours. Workload Rate = TB transferred * (2400 / recorded power on hours).		
Warranty	To determine the warranty for a specific drive, use a web browser to access the following web page: http://www.seagate.com/support/warranty-and-replacements/ . From this page, click on "Check to see if the drive is under Warranty". Users will be asked to provide the drive serial number, model number (or part number) and country of purchase. The system will display the warranty information for the drive.		
Contact start-stop cycles	50,000 at 25°C, 50% rel. humidity		
Supports Hotplug operation per the Serial ATA Revision 3.2 specification	Yes		

* All specifications above are based on native configurations.

** One GB equals one billion bytes and 1TB equals one trillion bytes when referring to hard drive capacity. Accessible capacity may vary depending on operating environment and formatting.

*** During periods of drive idle, some offline activity may occur according to the S.M.A.R.T. specification, which may increase acoustic and power to operational levels.

2.2 Formatted capacity

Model	Formatted capacity*	Guaranteed sectors	Bytes per sector
ST3000DM001 ST3000DM002	3000GB	5,860,533,168	4K
ST2000DM001 ST2000DM002	2000GB	3,907,029,168	
ST1500DM003	1500GB	2,930,277,168	
ST1000DM003 ST1000DM004	1000GB	1,953,525,168	
ST750DM003	750GB	1,465,149,168	
ST500DM002	500GB	976,773,168	
ST320DM000	320GB	625,142,448	
ST250DM000	250GB	488,397,168	

*One GB equals one billion bytes and 1TB equals one trillion bytes when referring to hard drive capacity. Accessible capacity may vary depending on operating environment and formatting.

2.2.1 LBA mode

When addressing these drives in LBA mode, all blocks (sectors) are consecutively numbered from 0 to $n-1$, where n is the number of guaranteed sectors as defined above.

See Section 5.3.1, "Identify Device command" (words 60-61 and 100-103) for additional information about 48-bit addressing support of drives with capacities over 137GB.

2.3 Default logical geometry

- **Cylinders:** 16,383
- **Read/write heads:** 16
- **Sectors per track:** 63

LBA mode

When addressing these drives in LBA mode, all blocks (sectors) are consecutively numbered from 0 to $n-1$, where n is the number of guaranteed sectors as defined above.

2.4 Recording and interface technology

Interface	SATA
Recording method	TGMR
Recording density (kFCI)	
3TB, 2TB, 1.5TB, 1TB and 750GB models	1807
500GB, 320GB and 250GB models	1413
Track density (ktracks/inch avg)	352
Areal density (Gb/in²)	
3TB, 2TB, 1.5TB, 1TB and 750GB models	625
500GB, 320GB, 250GB models	329
Spindle speed (RPM)	7200 ± 0.2%
Internal data transfer rate (Mb/s max)	2147
Maximum sustained data transfer rate, OD read (MB/s)	
3TB, 2TB, 1.5TB, 1TB and 750GB models	210
500GB, 320GB, 250GB models	144
Average data rate, read/write (MB/s)	
3TB, 2TB, 1.5TB, 1TB and 750GB models	156
500GB, 320GB, 250GB models	125
I/O data-transfer rate (MB/s max)	600

2.5 Physical characteristics

Maximum height	
3TB, 2TB and 1.5TB	26.1mm / 1.028 in
1TB, 750GB, 500GB, 320GB, 250GB	19.98mm / 0.787 in
Maximum width (all models)	101.6mm / 4.0 in (± 0.010 in)
Maximum length (all models)	146.99mm / 5.787 in
Typical weight	
3TB and 2TB	626g / 1.38 lb
1.5TB	535g / 1.18 lb
1TB and 750GB	400g / 0.88 lb
500GB, 320GB, 250GB	415g / 0.92 lb
Cache buffer	
3TB, 2TB, 1.5TB, 1TB, 750GB	64MB (64,768kb)
500GB, 320GB and 250GB	16MB (16,384kb)

2.6 Seek time

Seek measurements are taken with nominal power at 25°C ambient temperature. All times are measured using drive diagnostics. The specifications in the table below are defined as follows:

- Track-to-track seek time is an average of all possible single-track seeks in both directions.
- Average seek time is a true statistical random average of at least 5000 measurements of seeks between random tracks, less overhead.

Typical seek times (ms)	Read	Write
Track-to-track	1.0	1.2
Average	8.5	9.5
Average latency	4.16	

Note

These drives are designed to consistently meet the seek times represented in this manual. Physical seeks, regardless of mode (such as track-to-track and average), are expected to meet the noted values. However, due to the manner in which these drives are formatted, benchmark tests that include command overhead or measure logical seeks may produce results that vary from these specifications.

2.7 Start/stop times

	3-disk (3TB, 2TB models)	2-disk (2TB, 1.5TB models)	1-disk (1TB, 750GB models)	1-disk (250GB, 320GB, 500GB models)
Power-on to ready (in seconds)	15 (typical) 17 (max)		10 (typical) 12 (max)	8.5 (typical) 10 (max)
Power-on to ready, 2.5A spin-up code option (in seconds, typical)	<10		n/a	
Standby to ready (in seconds)	15 (typical) 17 (max)		10 (typical) 12 (max)	8.5 (typical) 10 (max)
Ready to spindle stop (in seconds)	10 (typical) 11 (max)		10 (typical) 11 (max)	

Time-to-ready may be longer than normal if the drive power is removed without going through normal OS powerdown procedures.

2.8 Power specifications

The drive receives DC power (+5V or +12V) through a native SATA power connector. Refer to Figure 1 on page 23.

2.8.1 Power consumption

Power requirements for the drives are listed in Table 3, Table 4, Table 5 and Table 6. Typical power measurements are based on an average of drives tested, under nominal conditions, using 5.0V and 12.0V input voltage at 25°C ambient temperature.

- **Spinup power**
Spinup power is measured from the time of power-on to the time that the drive spindle reaches operating speed.
- **Read/write power and current**
Read/write power is measured with the heads on track, based on a 16-sector write followed by a 32-ms delay, then a 16-sector read followed by a 32-ms delay.
- **Operating power and current**
Operating power is measured using 40 percent random seeks, 40 percent read/write mode (1 write for each 10 reads) and 20 percent drive idle mode.
- **Idle mode power**
Idle mode power is measured with the drive up to speed, with servo electronics active and with the heads in a random track location.
- **Standby mode**
During Standby mode, the drive accepts commands, but the drive is not spinning, and the servo and read/write electronics are in power-down mode.

Table 3 DC power requirements (3-disk: 3TB and 2TB models)

Power dissipation (3-disk values shown)	Avg (watts 25° C)	Avg 5V typ amps	Avg 12V amps
Spinup	—	—	2.0A or 2.8A
Idle2* †	5.40	0.190	0.377
Operating	8.00	0.510	0.462
Standby	0.75	0.136	0.005
Sleep	0.75	0.136	0.005

Table 4 DC power requirements (2-disk: 2TB and 1.5TB models)

Power dissipation (2-disk values shown)	Avg (watts 25° C)	Avg 5V typ amps	Avg 12V amps
Spinup	—	—	2.0A or 2.8A
Idle2* †	4.50	0.196	0.296
Operating	6.70	0.525	0.340
Standby	0.75	0.136	0.005
Sleep	0.75	0.136	0.005

Table 5 DC power requirements (1-disk: 1TB and 750GB models)

Power dissipation (1-disk values shown)	Avg (watts 25° C)	Avg 5V typ amps	Avg 12V amps
Spinup	—	—	2.0
Idle2* †	3.36	0.152	0.216
Operating	5.90	0.500	0.329
Standby	0.63	0.111	0.006
Sleep	0.63	0.111	0.006

Table 6 DC power requirements (1-disk: 500, 320 and 250GB models)

Power dissipation (1-disk values shown)	Avg (watts 25° C)	Avg 5V typ amps	Avg 12V typ amps
Spinup	—	—	2.0
Perf Idle* †	4.60	0.378	0.224
Operating	6.19	0.656	0.243
Standby	0.79	0.350	0.010
Sleep	0.79	0.350	0.010

*During periods of drive idle, some offline activity may occur according to the S.M.A.R.T. specification, which may increase acoustic and power to operational levels.

†5W IDLE with DIPLM Enabled

2.8.2 Conducted noise

Input noise ripple is measured at the host system power supply across an equivalent 80-ohm resistive load on the +12 volt line or an equivalent 15-ohm resistive load on the +5 volt line.

- Using 12-volt power, the drive is expected to operate with a maximum of 120 mV peak-to-peak square-wave injected noise at up to 10MHz.
- Using 5-volt power, the drive is expected to operate with a maximum of 100 mV peak-to-peak square-wave injected noise at up to 10MHz.

Note

Equivalent resistance is calculated by dividing the nominal voltage by the typical RMS read/write current.

2.8.3 Voltage tolerance

Voltage tolerance (including noise):

- 5V $\pm 5\%$
- 12V $+10\%$ / -7.5%

2.8.4 Power-management modes

The drive provides programmable power management to provide greater energy efficiency. In most systems, users can control power management through the system setup program. The drive features the following power-management modes:

Power modes	Heads	Spindle	Buffer
Active	Tracking	Rotating	Enabled
Idle	Tracking	Rotating	Enabled
Standby	Parked	Stopped	Enabled
Sleep	Parked	Stopped	Disabled

- **Active mode**
The drive is in Active mode during the read/write and seek operations.
- **Idle mode**
The buffer remains enabled, and the drive accepts all commands and returns to Active mode any time disk access is necessary.
- **Standby mode**
The drive enters Standby mode when the host sends a Standby Immediate command. If the host has set the standby timer, the drive can also enter Standby mode automatically after the drive has been inactive for a specifiable length of time. The standby timer delay is established using a Standby or Idle command. In Standby mode, the drive buffer is enabled, the heads are parked and the spindle is at rest. The drive accepts all commands and returns to Active mode any time disk access is necessary.
- **Sleep mode**
The drive enters Sleep mode after receiving a Sleep command from the host. In Sleep mode, the drive buffer is disabled, the heads are parked and the spindle is at rest. The drive leaves Sleep mode after it receives a Hard Reset or Soft Reset from the host. After receiving a reset, the drive exits Sleep mode and enters Standby mode with all current translation parameters intact.
- **Idle and Standby timers**
Each time the drive performs an Active function (read, write or seek), the standby timer is reinitialized and begins counting down from its specified delay times to zero. If the standby timer reaches zero before any drive activity is required, the drive makes a transition to Standby mode. In both Idle and Standby mode, the drive accepts all commands and returns to Active mode when disk access is necessary.

2.9 Environmental specifications

This section provides the temperature, humidity, shock, and vibration specifications. Ambient temperature is defined as the temperature of the environment immediately surrounding the drive. Above 1000ft. (305 meters), the maximum temperature is derated linearly by 1°C every 1000 ft.

Note	The maximum allowable drive case temperature is 60°C. See Figures 2 & 3 for HDA case temperature measurement locations.
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Refer to Section 3.4 Drive mounting for base plate measurement location.

2.9.1 Ambient temperature

Operating	0° to 60°C (32° to 140°F)
Non-operating	–40° to 70°C (–40° to 158°F)

2.9.2 Temperature gradient

Operating	20°C per hour (68°F per hour max), without condensation
Non-operating	30°C per hour (86°F per hour max)

2.9.3 Humidity

2.9.3.1 Relative humidity

Operating	5% to 95% non-condensing (30% per hour max)
Nonoperating	5% to 95% non-condensing (30% per hour max)

2.9.3.2 Wet bulb temperature

Operating	37.7°C (99.9°F max)
Non-operating	40°C (104°F max)

2.9.4 Altitude

Operating	–304.8m to 3048m (–1000 ft. to 10,000+ ft.)
Non-operating	–304.8m to 12,192m (–1000 ft. to 40,000+ ft.)

Note	Maximum storage condition not to exceed 90 days at a wetbulb temperature of 32°C (example: 34°C / 90% RH)
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2.9.5 Shock

All shock specifications assume that the drive is mounted securely with the input shock applied at the drive mounting screws. Shock may be applied in the X, Y or Z axis.

2.9.5.1 Operating shock

These drives comply with the performance levels specified in this document when subjected to a maximum operating shock of 80 Gs based on half-sine shock pulses of 2 ms during read operations. Shocks should not be repeated more than two times per second.

2.9.5.2 Non-operating shock

3TB, 2TB and 1.5TB models

The non-operating shock level that the drive can experience without incurring physical damage or degradation in performance when subsequently put into operation is 300 Gs based on a non-repetitive half-sine shock pulse of 2 ms duration.

1TB, 750GB, 500GB, 320GB and 250GB models

The non-operating shock level that the drive can experience without incurring physical damage or degradation in performance when subsequently put into operation is 350 Gs based on a non-repetitive half-sine shock pulse of 2-ms duration.

2.9.5.3 Operating vibration

The maximum vibration levels that the drive may experience while meeting the performance standards specified in this document are specified below.

2Hz to 22Hz	0.25 Gs (Limited displacement)
22Hz to 350Hz	0.50 Gs
350Hz to 500Hz	0.25 Gs

All vibration specifications assume that the drive is mounted securely with the input vibration applied at the drive mounting screws. Vibration may be applied in the X, Y or Z axis. Throughput may vary if improperly mounted.

2.9.6 Non-operating vibration

The maximum non-operating vibration levels that the drive may experience without incurring physical damage or degradation in performance when subsequently put into operation are specified below.

5Hz to 22Hz	3.0 Gs (Limited displacement)
22Hz to 350Hz	3.0 Gs
350Hz to 500Hz	3.0 Gs

2.10 Acoustics

Drive acoustics are measured as overall A-weighted acoustic sound power levels (no pure tones). All measurements are consistent with ISO document 7779. Sound power measurements are taken under essentially free-field conditions over a reflecting plane. For all tests, the drive is oriented with the cover facing upward.

Note

For seek mode tests, the drive is placed in seek mode only. The number of seeks per second is defined by the following equation:

(Number of seeks per second = $0.4 / (\text{average latency} + \text{average access time})$)

Table 7 Fluid Dynamic Bearing (FDB) motor acoustics

	Idle*	Seek
3 Disks (3TB, 2TB)	2.4 bels (typical) 2.6 bels (max)	2.6 bels (typical) 2.7 bels (max)
2 Disks (2TB, 1.5TB)		
1 Disk (1TB, 750GB)	2.2 bels (typical) 2.3 bels (max)	2.3 bels (typical) 2.4 bels (max)
1 Disk (500GB, 320GB, 250GB)	2.2 bels (typical) 2.4 bels (max)	2.4 bels (typical) 2.5 bels (max)

*During periods of drive idle, some offline activity may occur according to the S.M.A.R.T. specification, which may increase acoustic and power to operational levels.

2.10.1 Test for Prominent Discrete Tones (PDTs)

Seagate follows the ECMA-74 standards for measurement and identification of PDTs. An exception to this process is the use of the absolute threshold of hearing. Seagate uses this threshold curve (originated in ISO 389-7) to discern tone audibility and to compensate for the inaudible components of sound prior to computation of tone ratios according to Annex D of the ECMA-74 standards.

2.11 Electromagnetic immunity

When properly installed in a representative host system, the drive operates without errors or degradation in performance when subjected to the radio frequency (RF) environments defined in Table 8.

Table 8 Radio frequency environments

Test	Description	Performance level	Reference standard
Electrostatic discharge	Contact, HCP, VCP: ± 4 kV; Air: ± 8 kV	B	EN61000-4-2: 95
Radiated RF immunity	80MHz to 1,000MHz, 3 V/m, 80% AM with 1kHz sine 900MHz, 3 V/m, 50% pulse modulation @ 200Hz	A	EN61000-4-3: 96 ENV50204: 95
Electrical fast transient	± 1 kV on AC mains, ± 0.5 kV on external I/O	B	EN61000-4-4: 95
Surge immunity	± 1 kV differential, ± 2 kV common, AC mains	B	EN61000-4-5: 95
Conducted RF immunity	150kHz to 80MHz, 3 Vrms, 80% AM with 1kHz sine	A	EN61000-4-6: 97
Voltage dips, interrupts	0% open, 5 seconds 0% short, 5 seconds 40%, 0.10 seconds 70%, 0.01 seconds	C C C B	EN61000-4-11: 94

2.12 Reliability

2.12.1 Annualized Failure Rate (AFR)

The production disk drive shall achieve an annualized failure-rate of <1.0% over a 5 year service life when used in Desktop Storage field conditions as limited by the following:

- 2400 power-on-hours per year.
- Typical workload

Nonrecoverable read errors	1 per 10 ¹⁴ bits read, max
Maximum Rated Workload	Maximum rate of <55TB/year Workloads exceeding the annualized rate may impact product reliability. The Annualized Workload Rate is in units of TB per year, or TB per 2400 power on hours. Workload Rate = TB transferred * (2400 / recorded power on hours).
Warranty	To determine the warranty for a specific drive, use a web browser to access the following web page: http://www.seagate.com/support/warranty-and-replacements/ . From this page, click on the "Check to see if the drive is under Warranty" link. The following are required to be provided: the drive serial number, model number (or part number) and country of purchase. The system will display the warranty information for the drive.
Preventive maintenance	None required.

2.13 Warranty

To determine the warranty for a specific drive, use a web browser to access the following web page:
<http://www.seagate.com/support/warranty-and-replacements/>

From this page, click on "Check to see if the drive is under Warranty". Users will be asked to provide the drive serial number, model number (or part number) and country of purchase. The system will display the warranty information for the drive.

2.14 Agency certification

2.14.1 Safety certification

These products are certified to meet the requirements of UL60950-1, CSA60950-1 and EN60950 and so marked as to the certify agency.

2.14.2 Electromagnetic compatibility

Hard drives that display the CE mark comply with the European Union (EU) requirements specified in the Electromagnetic Compatibility Directive (2004/108/EC) as put into place 20 July 2007. Testing is performed to the levels specified by the product standards for Information Technology Equipment (ITE). Emission levels are defined by EN 55022, Class B and the immunity levels are defined by EN 55024.

Drives are tested in representative end-user systems. Although CE-marked Seagate drives comply with the directives when used in the test systems, we cannot guarantee that all systems will comply with the directives. The drive is designed for operation inside a properly designed enclosure, with properly shielded I/O cable (if necessary) and terminators on all unused I/O ports. Computer manufacturers and system integrators should confirm EMC compliance and provide CE marking for their products.

Korean RRL

If these drives have the Korean Communications Commission (KCC) logo, they comply with paragraph 1 of Article 11 of the Electromagnetic Compatibility control Regulation and meet the Electromagnetic Compatibility (EMC) Framework requirements of the Radio Research Laboratory (RRL) Communications Commission, Republic of Korea.

These drives have been tested and comply with the Electromagnetic Interference/Electromagnetic Susceptibility (EMI/EMS) for Class B products. Drives are tested in a representative, end-user system by a Korean-recognized lab.

- Family name: Barracuda
- Certificate number: KCC-REM-STX-Barracuda

Australian C-Tick (N176)

If these models have the C-Tick marking, they comply with the Australia/New Zealand Standard AS/NZ CISPR22 and meet the Electromagnetic Compatibility (EMC) Framework requirements of the Australian Communication Authority (ACA).

2.14.3 FCC verification

These drives are intended to be contained solely within a personal computer or similar enclosure (not attached as an external device). As such, each drive is considered to be a subassembly even when it is individually marketed to the customer. As a subassembly, no Federal Communications Commission verification or certification of the device is required.

Seagate has tested this device in enclosures as described above to ensure that the total assembly (enclosure, disk drive, motherboard, power supply, etc.) does comply with the limits for a Class B computing device, pursuant to Subpart J, Part 15 of the FCC rules. Operation with non-certified assemblies is likely to result in interference to radio and television reception.

Radio and television interference. This equipment generates and uses radio frequency energy and if not installed and used in strict accordance with the manufacturer's instructions, may cause interference to radio and television reception.

This equipment is designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television, which can be determined by turning the equipment on and off, users are encouraged to try one or more of the following corrective measures:

- Reorient the receiving antenna.
- Move the device to one side or the other of the radio or TV.
- Move the device farther away from the radio or TV.
- Plug the computer into a different outlet so that the receiver and computer are on different branch outlets.

If necessary, users should consult the dealer or an experienced radio/television technician for additional suggestions. Users may find helpful the following booklet prepared by the Federal Communications Commission: *How to Identify and Resolve Radio-Television Interference Problems*. This booklet is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Refer to publication number 004-000-00345-4.

2.15 Environmental protection

Seagate designs its products to meet environmental protection requirements worldwide, including regulations restricting certain chemical substances.

2.15.1 European Union Restriction of Hazardous Substances (RoHS) Directive

The European Union Restriction of Hazardous Substances (RoHS) Directive, restricts the presence of chemical substances, including Lead, Cadmium, Mercury, Hexavalent Chromium, PBB and PBDE, in electronic products, effective July 2006. This drive is manufactured with components and materials that comply with the RoHS Directive.

2.15.2 China Restriction of Hazardous Substances (RoHS) Directive 中国限制危险物品的指令

This product has an Environmental Protection Use Period (EPUP) of 20 years. The following table contains information mandated by China's "Marking Requirements for Control of Pollution Caused by Electronic Information Products" Standard.



该产品具有20年的环境保护使用周期（EPUP）。下表包含了中国“电子产品所导致的污染的控制的记号要求”所指定的信息。

Name of Parts 部件名称	Toxic or Hazardous Substances or Elements 有毒有害物质或元素					
	Lead 铅 (Pb)	Mercury 汞 (Hg)	Cadmium 镉 (Cd)	Hexavalent Chromium 六价铬 (Cr6+)	Polybrominated Diphenyl 多溴联苯 (PBB)	Polybrominated Diphenyl Ether 多溴二苯醚 (PBDE)
PCBA	X	O	O	O	O	O
HDA	X	O	O	O	O	O

"O" indicates the hazardous and toxic substance content of the part (at the homogeneous material level) is lower than the threshold defined by the China RoHS MCV Standard.

“O”表示该部件（于同类物品程度上）所含的危险和有毒物质低于中国RoHS MCV标准所定义的门槛值。

"X" indicates the hazardous and toxic substance content of the part (at the homogeneous material level) is over the threshold defined by the China RoHS MCV Standard.

“X”表示该部件（于同类物品程度上）所含的危险和有毒物质超出中国RoHS MCV标准所定义的门槛值。

2.16 Corrosive environment

Seagate electronic drive components pass accelerated corrosion testing equivalent to 10 years exposure to light industrial environments containing sulfurous gases, chlorine and nitric oxide, classes G and H per ASTM B845. However, this accelerated testing cannot duplicate every potential application environment. Users should use caution exposing any electronic components to uncontrolled chemical pollutants and corrosive chemicals as electronic drive component reliability can be affected by the installation environment. The silver, copper, nickel and gold films used in Seagate products are especially sensitive to the presence of sulfide, chloride, and nitrate contaminants. Sulfur is found to be the most damaging. In addition, electronic components should never be exposed to condensing water on the surface of the printed circuit board assembly (PCBA) or exposed to an ambient relative humidity greater than 95%. Materials used in cabinet fabrication, such as vulcanized rubber, that can outgas corrosive compounds should be minimized or eliminated. The useful life of any electronic equipment may be extended by replacing materials near circuitry with sulfide-free alternatives.

3.0 Configuring and Mounting the Drive

This section contains the specifications and instructions for configuring and mounting the drive.

3.1 Handling and static-discharge precautions

After unpacking, and before installation, the drive may be exposed to potential handling and electrostatic discharge (ESD) hazards. Observe the following standard handling and static-discharge precautions:

Caution

- Before handling the drive, put on a grounded wrist strap, or ground oneself frequently by touching the metal chassis of a computer that is plugged into a grounded outlet. Wear a grounded wrist strap throughout the entire installation procedure.
- Handle the drive by its edges or frame *only*.
- The drive is extremely fragile—handle it with care. Do not press down on the drive top cover.
- Always rest the drive on a padded, antistatic surface until mounting it in the computer.
- Do not touch the connector pins or the printed circuit board.
- Do not remove the factory-installed labels from the drive or cover them with additional labels. Removal voids the warranty. Some factory-installed labels contain information needed to service the drive. Other labels are used to seal out dirt and contamination.

3.2 Configuring the drive

Each drive on the SATA interface connects point-to-point with the SATA host adapter. There is no master/slave relationship because each drive is considered a master in a point-to-point relationship. If two drives are attached on one SATA host adapter, the host operating system views the two devices as if they were both “masters” on two separate ports. Both drives behave as if they are Device 0 (master) devices.

SATA drives are designed for easy installation. It is usually not necessary to set any jumpers on the drive for proper operation; however, if users connect the drive and receive a “drive not detected” error, the SATA-equipped motherboard or host adapter may use a chipset that does not support SATA speed autonegotiation.

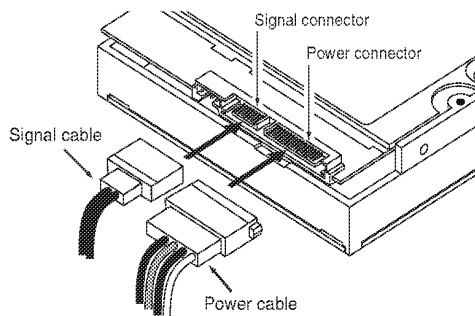
3.3 SATA cables and connectors

The SATA interface cable consists of four conductors in two differential pairs, plus three ground connections. The cable size may be 30 to 26 AWG with a maximum length of one meter (39.37 inches). See Table 9 for connector pin definitions. Either end of the SATA signal cable can be attached to the drive or host.

For direct backplane connection, the drive connectors are inserted directly into the host receptacle. The drive and the host receptacle incorporate features that enable the direct connection to be hot pluggable and blind mateable.

For installations which require cables, users can connect the drive as illustrated in Figure 1.

Figure 1 Attaching SATA cabling



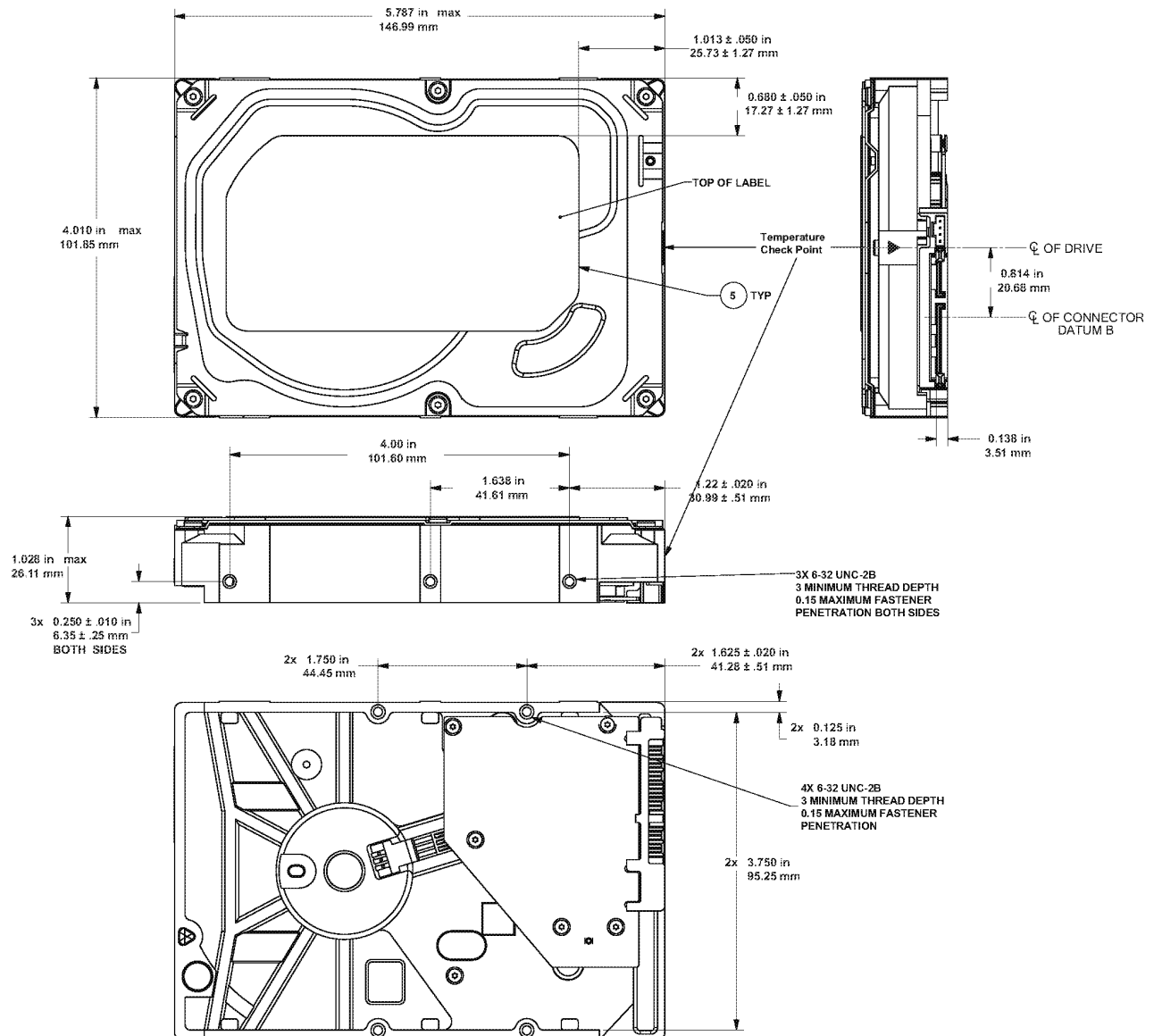
Each cable is keyed to ensure correct orientation. Desktop HDD drives support latching SATA connectors.

3.4 Drive mounting

Users can mount the drive in any orientation using four screws in the side-mounting holes or four screws in the bottom-mounting holes. Refer to Figure 2 and Figure 3 for drive mounting dimensions. Follow these important mounting precautions when mounting the drive:

- Allow a minimum clearance of 0.030 inches (0.76mm) around the entire perimeter of the drive for cooling.
- Use only 6-32 UNC mounting screws.
- The screws should be inserted no more than 0.150 inch (3.81mm) into the bottom or side mounting holes.
- Do not overtighten the mounting screws (maximum torque: 6 inch-lb).

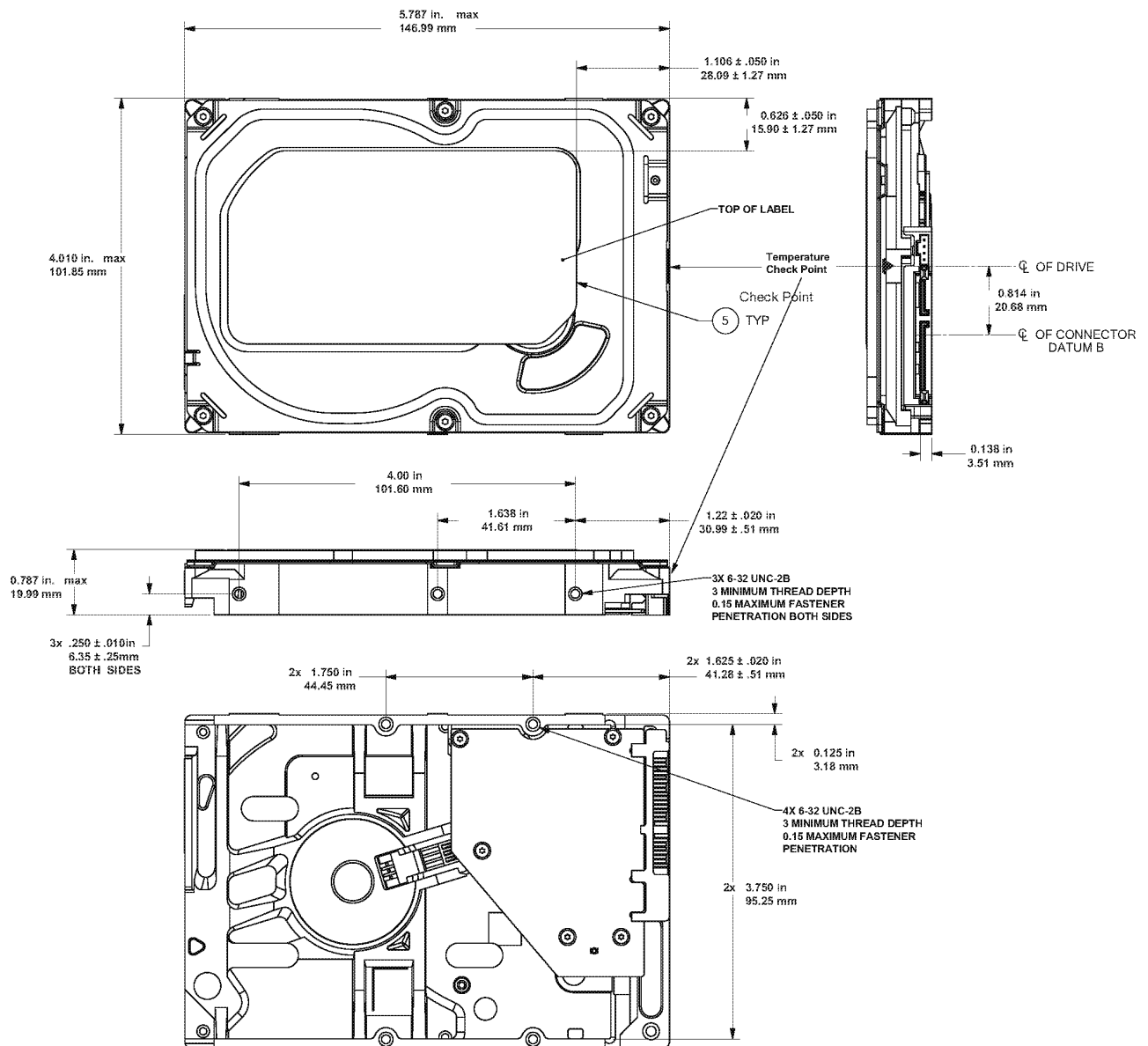
Figure 2 Mounting dimensions (3-disk: 1.5TB to 3TB models)



Note

Drawings are for mounting hole reference only.
PCBA show in pictorial only and can vary based on specific customer configurations.

Figure 3 Mounting dimensions (1-disk: 250GB to 1TB models)



Note

Drawings are for mounting hole reference only.
PCBA show in pictorial only and can vary based on specific customer configurations.

4.0 About (SED) Self-Encrypting Drives

Self-encrypting drives (SEDs) offer encryption and security services for the protection of stored data, commonly known as "protection of data at rest". These drives are compliant with the Trusted Computing Group (TCG) Opal Storage Specifications as detailed in the following:

Trusted Computing Group (TCG) Documents (apply to Self-Encrypting Drive models only)
 TCG Storage Architecture Core Specification, Version 2.0
 TCG Storage Security Subsystem Class Opal Specification, Version 2.0
 (see www.trustedcomputinggroup.org)

In case of conflict between this document and any referenced document, this document takes precedence.

The Trusted Computing Group (TCG) is an organization sponsored and operated by companies in the computer, storage and digital communications industry. Seagate's SED models comply with the standards published by the TCG.

To use the security features in the drive, the host must be capable of constructing and issuing the following two SATA commands:

- Trusted Send
- Trusted Receive

These commands are used to convey the TCG protocol to and from the drive in their command payloads.

4.1 Data Encryption

Encrypting drives use one inline encryption engine for each drive employing AES-256 data encryption in Cipher Block Chaining (CBC) mode to encrypt all data prior to being written on the media and to decrypt all data as it is read from the media. The encryption engine is always in operation and cannot be disabled.

The 32-byte Data Encryption Key (DEK) is a random number which is generated by the drive, never leaves the drive, and is inaccessible to the host system. The DEK is itself encrypted when it is stored on the media and when it is in volatile temporary storage (DRAM) external to the encryption engine. A unique data encryption key is used for each of the drive's possible 16 data bands (see [Section 4.5 Data Bands](#)).

4.2 Controlled Access

The drive has two security providers (SPs) called the "Admin SP" and the "Locking SP." These act as gatekeepers to the drive security services. Security-related commands will not be accepted unless they also supply the correct credentials to prove the requester is authorized to perform the command.

4.2.1 Admin SP

The Admin SP allows the drive's owner to enable or disable firmware download operations (see [Section 4.4 Drive Locking](#)). Access to the Admin SP is available using the SID (Secure ID) password or the MSID (Manufacturers Secure ID) password.

4.2.2 Locking SP

The Locking SP controls read/write access to the media and the cryptographic erase feature. Access to the Locking SP is available using the Admin or User passwords.

4.2.3 Default password

When the drive is shipped from the factory, all passwords are set to the value of MSID. This 32-byte random value can only be read by the host electronically over the interface. After receipt of the drive, it is the responsibility of the owner to use the default MSID password as the authority to change all other passwords to unique owner-specified values.

4.2.4 ATA Enhanced Security

The drive can utilize the system's BIOS through the ATA Security API for cases that do not require password management and additional security policies.

Furthermore, the drive's ATA Security Erase Unit command shall support both Normal and Enhanced Erase modes with the following modifications/additions:

Normal Erase: Normal erase feature shall be performed by changing the Data Encryption Key (DEK) of the drive, followed by an overwrite operation that repeatedly writes a single sector containing random data to the entire drive. This write operation bypasses the media encryption. On reading back the overwritten sectors, the host will receive a decrypted version, using the new DEK of the random data sector (the returned data will not match what was written).

Enhanced Erase: Enhanced erase shall be performed by changing the Data Encryption Key of the drive.

4.3 Random Number Generator (RNG)

The drive has a 32-byte hardware RNG that it is using to derive encryption keys or, if requested to do so, to provide random numbers to the host for system use, including using these numbers as Authentication Keys (passwords) for the drive's Admin and Locking SPs.

4.4 Drive Locking

In addition to changing the passwords, as described in **Section 4.2.3 Default password**, the owner should also set the data access controls for the individual bands.

The variable "LockOnReset" should be set to "PowerCycle" to ensure that the data bands will be locked if power is lost. In addition "ReadLockEnabled" and "WriteLockEnabled" must be set to true in the locking table in order for the bands "LockOnReset" setting of "PowerCycle" to actually lock access to the band when a "PowerCycle" event occurs. This scenario occurs if the drive is removed from its cabinet. The drive will not honor any data read or write requests until the bands have been unlocked. This prevents the user data from being accessed without the appropriate credentials when the drive has been removed from its cabinet and installed in another system.

4.5 Data Bands

When shipped from the factory, the drive is configured with a single data band called Band 0 (also known as the Global Data Band) which comprises LBA 0 through LBA max. The host may allocate additional bands (Band1 to Band15) by specifying a start LBA and an LBA range. The real estate for this band is taken from the Global Band.

Data bands cannot overlap but they can be sequential with one band ending at LBA (x) and the next beginning at LBA (x+1).

Each data band has its own drive-generated encryption key. The host may change the Encryption Key (see **Section 4.6 Cryptographic Erase**) or the password when required. The bands should be aligned to 4K LBA boundaries.

4.6 Cryptographic Erase

A significant feature of SEDs is the ability to perform a cryptographic erase. This involves the host telling the drive to change the data encryption key for a particular band. Once changed, the data is no longer recoverable since it was written with one key and will be read using a different key. Since the drive overwrites the old key with the new one, and keeps no history of key changes, the user data can never be recovered. This is tantamount to an instantaneous data erase and is very useful if the drive is to be scrapped or redispositioned.

4.7 Authenticated Firmware Download

In addition to providing a locking mechanism to prevent unwanted firmware download attempts, the drive also only accepts download files which have been cryptographically signed by the appropriate Seagate Design Center.

Three conditions must be met before the drive will allow the download operation:

1. The download must be an SED file. A standard (base) drive (non-SED) file will be rejected.
2. The download file must be signed and authenticated.
3. As with a non-SED drive, the download file must pass the acceptance criteria for the drive. For example it must be applicable to the correct drive model, and have compatible revision and customer status.

4.8 Power Requirements

The standard drive models and the SED drive models have identical hardware, however the security and encryption portion of the drive controller ASIC is enabled and functional in the SED models. This represents a small additional drain on the 5V supply of about

30mA and a commensurate increase of about 150mW in power consumption. There is no additional drain on the 12V supply. See the tables in **Section 2.8 Power specifications** for power requirements on the standard (non-SED) drive models.

4.9 Supported Commands

The SED models support the following two commands in addition to the commands supported by the standard (non-SED) models as listed in **Table 10**:

- Trusted Send
- Trusted Receive

4.10 RevertSP

SED models will support the RevertSP feature which erases all data in all bands on the device and returns the contents of all SPs (Security Providers) on the device to their original factory state. In order to execute the RevertSP method the unique PSID (Physical Secure ID) printed on the drive label must be provided. PSID is not electronically accessible and can only be manually read from the drive label or scanned in via the 2D barcode.

5.0 SATA Interface

These drives use the industry-standard Serial ATA (SATA) interface that supports FIS data transfers. It supports ATA programmed input/output (PIO) modes 0 to 4; multiword DMA modes 0 to 2, and Ultra DMA modes 0 to 6.

For detailed information about the SATA interface, refer to the “Serial ATA: High Speed Serialized AT Attachment” specification.

5.1 Hot-Plug compatibility

Desktop HDD drives incorporate connectors which enable users to hot plug these drives in accordance with the SATA Revision 3.2 specification. This specification can be downloaded from www.serialata.org.

5.2 SATA device plug connector pin definitions

Table 9 summarizes the signals on the SATA interface and power connectors.

Table 9 SATA connector pin definitions

Segment	Pin	Function	Definition
Signal	S1	Ground	2nd mate
	S2	A+	Differential signal pair A from Phy
	S3	A-	
	S4	Ground	2nd mate
	S5	B-	Differential signal pair B from Phy
	S6	B+	
	S7	Ground	2nd mate
Key and spacing separate signal and power segments			
Power	P1	V ₃₃	3.3V power
	P2	V ₃₃	3.3V power
	P3	V ₃₃	3.3V power, pre-charge, 2nd mate
	P4	Ground	1st mate
	P5	Ground	2nd mate
	P6	Ground	2nd mate
	P7	V ₅	5V power, pre-charge, 2nd mate
	P8	V ₅	5V power
	P9	V ₅	5V power
	P10	Ground	2nd mate
	P11	Ground or LED signal	If grounded, drive does not use deferred spin
	P12	Ground	1st mate.
	P13	V ₁₂	12V power, pre-charge, 2nd mate
	P14	V ₁₂	12V power
	P15	V ₁₂	12V power

Notes

- All pins are in a single row, with a 1.27 mm (0.050 in) pitch.
- The comments on the mating sequence apply to the case of backplane blindmate connector only. In this case, the mating sequences are:
 - the ground pins P4 and P12.
 - the pre-charge power pins and the other ground pins.
 - the signal pins and the rest of the power pins.
- There are three power pins for each voltage. One pin from each voltage is used for pre-charge when installed in a blind-mate backplane configuration.
 - All used voltage pins (V_x) must be terminated.

5.3 Supported ATA commands

The following table lists SATA standard commands that the drive supports.

For a detailed description of the ATA commands, refer to the Serial ATA International Organization: Serial ATA Revision 3.0 (<http://www.sata-io.org>).

See “S.M.A.R.T. commands” on page 36 for details and subcommands used in the S.M.A.R.T. implementation.

Table 10 SATA standard commands

Command name	Command code (in hex)
Check Power Mode	E5 _H
Device Configuration Freeze Lock	B1 _H / C1 _H
Device Configuration Identify	B1 _H / C2 _H
Device Configuration Restore	B1 _H / C0 _H
Device Configuration Set	B1 _H / C3 _H
Device Reset	08 _H
Download Microcode	92 _H
Execute Device Diagnostics	90 _H
Flush Cache	E7 _H
Flush Cache Extended	EA _H
Format Track	50 _H
Identify Device	EC _H
Idle	E3 _H
Idle Immediate	E1 _H
Initialize Device Parameters	91 _H
Read Buffer	E4 _H
Read DMA	C8 _H
Read DMA Extended	25 _H
Read DMA Without Retries	C9 _H
Read Log Ext	2F _H
Read Multiple	C4 _H
Read Multiple Extended	29 _H
Read Native Max Address	F8 _H
Read Native Max Address Extended	27 _H
Read Sectors	20 _H
Read Sectors Extended	24 _H
Read Sectors Without Retries	21 _H
Read Verify Sectors	40 _H
Read Verify Sectors Extended	42 _H
Read Verify Sectors Without Retries	41 _H
Recalibrate	10 _H
Security Disable Password	F6 _H
Security Erase Prepare	F3 _H
Security Erase Unit	F4 _H

Table 10 SATA standard commands (continued)

Command name	Command code (in hex)	
Security Freeze	F5 _H	
Security Set Password	F1 _H	
Security Unlock	F2 _H	
Seek	70 _H	
Set Features	EF _H	
Set Max Address	F9 _H	
Note: Individual Set Max Address commands are identified by the value placed in the Set Max Features register as defined to the right.	Address: Password: Lock: Unlock: Freeze Lock:	00 _H 01 _H 02 _H 03 _H 04 _H
Set Max Address Extended	37 _H	
Set Multiple Mode	C6 _H	
Sleep	E6 _H	
S.M.A.R.T. Disable Operations	B0 _H / D9 _H	
S.M.A.R.T. Enable/Disable Autosave	B0 _H / D2 _H	
S.M.A.R.T. Enable Operations	B0 _H / D8 _H	
S.M.A.R.T. Execute Offline	B0 _H / D4 _H	
S.M.A.R.T. Read Attribute Thresholds	B0 _H / D1 _H	
S.M.A.R.T. Read Data	B0 _H / D0 _H	
S.M.A.R.T. Read Log Sector	B0 _H / D5 _H	
S.M.A.R.T. Return Status	B0 _H / DA _H	
S.M.A.R.T. Save Attribute Values	B0 _H / D3 _H	
S.M.A.R.T. Write Log Sector	B0 _H / D6 _H	
Standby	E2 _H	
Standby Immediate	E0 _H	
Write Buffer	E8 _H	
Write DMA	CA _H	
Write DMA Extended	35 _H	
Write DMA FUA Extended	3D _H	
Write DMA Without Retries	CB _H	
Write Log Extended	3F _H	
Write Multiple	C5 _H	
Write Multiple Extended	39 _H	
Write Multiple FUA Extended	CE _H	
Write Sectors	30 _H	
Write Sectors Without Retries	31 _H	
Write Sectors Extended	34 _H	
Write Uncorrectable	45 _H	

5.3.1 Identify Device command

The Identify Device command (command code EC_H) transfers information about the drive to the host following power up. The data is organized as a single 512-byte block of data, whose contents are shown in on page 29. All reserved bits or words should be set to zero. Parameters listed with an “x” are drive-specific or vary with the state of the drive.

The following commands contain drive-specific features that may not be included in the SATA specification.

Table 11 Identify Device commands

Word	Description	Value
0	Configuration information: <ul style="list-style-type: none"> • Bit 15: 0 = ATA; 1 = ATAPI • Bit 7: removable media • Bit 6: removable controller • Bit 0: reserved 	0C5A _H
1	Number of logical cylinders	16,383
2	ATA-reserved	0000 _H
3	Number of logical heads	16
4	Retired	0000 _H
5	Retired	0000 _H
6	Number of logical sectors per logical track: 63	003F _H
7–9	Retired	0000 _H
10–19	Serial number: (20 ASCII characters, 0000 _H = none)	ASCII
20	Retired	0000 _H
21	Retired	0400 _H
22	Obsolete	0000 _H
23–26	Firmware revision (8 ASCII character string, padded with blanks to end of string)	x.xx
27–46	Drive model number: (40 ASCII characters, padded with blanks to end of string)	
47	(Bits 7–0) Maximum sectors per interrupt on Read multiple and Write multiple (16)	8010 _H
48	Reserved	0000 _H
49	Standard Standby timer, IORDY supported and may be disabled	2F00 _H
50	ATA-reserved	0000 _H
51	PIO data-transfer cycle timing mode	0200 _H
52	Retired	0200 _H
53	Words 54–58, 64–70 and 88 are valid	0007 _H
54	Number of current logical cylinders	xxxx _H
55	Number of current logical heads	xxxx _H
56	Number of current logical sectors per logical track	xxxx _H
57–58	Current capacity in sectors	xxxx _H

Table 11 Identify Device commands (continued)

Word	Description	Value
59	Number of sectors transferred during a Read Multiple or Write Multiple command	xxxx _H
60–61	Total number of user-addressable LBA sectors available (see Section 2.2 for related information) *Note: The maximum value allowed in this field is: 0FFFFFFF _H (268,435,455 sectors, 137GB). Drives with capacities over 137GB will have 0FFFFFFF _H in this field and the actual number of user-addressable LBAs specified in words 100–103. This is required for drives that support the 48-bit addressing feature.	0FFFFFFF _H *
62	Retired	0000 _H
63	Multiword DMA active and modes supported (see note following this table)	xx07 _H
64	Advanced PIO modes supported (modes 3 and 4 supported)	0003 _H
65	Minimum multiword DMA transfer cycle time per word (120 nsec)	0078 _H
66	Recommended multiword DMA transfer cycle time per word (120 nsec)	0078 _H
67	Minimum PIO cycle time without IORDY flow control (240 nsec)	0078 _H
68	Minimum PIO cycle time with IORDY flow control (120 nsec)	0078 _H
69–74	ATA-reserved	0000 _H
75	Queue depth	001F _H
76	SATA capabilities	xxxx _H
77	Reserved for future SATA definition	xxxx _H
78	SATA features supported	xxxx _H
79	SATA features enabled	xxxx _H
80	Major version number	01F0 _H
81	Minor version number	0028 _H
82	Command sets supported	364B _H
83	Command sets supported	7F09 _H
84	Command sets support extension (see note following this table)	4163 _H
85	Command sets enabled	30xx _H
86	Command sets enabled	BE09 _H
87	Command sets enable extension	4163 _H
88	Ultra DMA support and current mode (see note following this table)	xx7F _H
89	Security erase time	0039 _H
90	Enhanced security erase time	0039 _H
92	Master password revision code	FFFE _H
93	Hardware reset value	xxxx _H
94	Automatic acoustic management	8080 _H
95–99	ATA-reserved	0000 _H

Table 11 Identify Device commands (continued)

Word	Description	Value
100–103	Total number of user-addressable LBA sectors available (see Section 2.2 for related information). These words are required for drives that support the 48-bit addressing feature. Maximum value: 0000FFFFFFFFFh.	ST3000DM001 = 5,860,533,168 ST3000DM002 = 5,860,533,168 ST2000DM001 = 3,907,029,168 ST2000DM002 = 3,907,029,168 ST1500DM003 = 2,930,277,168 ST1000DM003 = 1,953,525,168 ST1000DM004 = 1,953,525,168 ST750DM003 = 1,465,149,168 ST500DM002 = 976,773,168 ST320DM000 = 625,142,448 ST250DM000 = 488,397,168
104–107	ATA-reserved	0000 _H
108–111	The mandatory value of the world wide name (WWN) for the drive. NOTE: This field is valid if word 84, bit 8 is set to 1 indicating 64-bit WWN support.	Each drive will have a unique value.
112–127	ATA-reserved	0000 _H
128	Security status	0001 _H
129–159	Seagate-reserved	xxxx _H
160–254	ATA-reserved	0000 _H
255	Integrity word	xxA5 _H

Note

Advanced Power Management (APM) and Automatic Acoustic Management (AAM) features are not supported.

Note

See the bit descriptions below for words 63, 84, and 88 of the Identify Drive data.

Description (if bit is set to 1)		
	Bit	Word 63
	0	Multiword DMA mode 0 is supported.
	1	Multiword DMA mode 1 is supported.
	2	Multiword DMA mode 2 is supported.
	8	Multiword DMA mode 0 is currently active.
	9	Multiword DMA mode 1 is currently active.
	10	Multiword DMA mode 2 is currently active.
	Bit	Word 84
	0	SMART error login is supported.
	1	SMART self-test is supported.
	2	Media serial number is supported.
	3	Media Card Pass Through Command feature set is supported.
	4	Streaming feature set is supported.
	5	GPL feature set is supported.

	6	WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands are supported.
	7	WRITE DMA QUEUED FUA EXT command is supported.
	8	64-bit World Wide Name is supported.
	9-10	Obsolete.
	11-12	Reserved for TLC.
	13	IDLE IMMEDIATE command with IUNLOAD feature is supported.
	14	Shall be set to 1.
	15	Shall be cleared to 0.
	Bit	Word 88
	0	Ultra DMA mode 0 is supported.
	1	Ultra DMA mode 1 is supported.
	2	Ultra DMA mode 2 is supported.
	3	Ultra DMA mode 3 is supported.
	4	Ultra DMA mode 4 is supported.
	5	Ultra DMA mode 5 is supported.
	6	Ultra DMA mode 6 is supported.
	8	Ultra DMA mode 0 is currently active.
	9	Ultra DMA mode 1 is currently active.
	10	Ultra DMA mode 2 is currently active.
	11	Ultra DMA mode 3 is currently active.
	12	Ultra DMA mode 4 is currently active.
	13	Ultra DMA mode 5 is currently active.
	14	Ultra DMA mode 6 is currently active.

5.3.2 Set Features command

This command controls the implementation of various features that the drive supports. When the drive receives this command, it sets BSY, checks the contents of the Features register, clears BSY and generates an interrupt. If the value in the register does not represent a feature that the drive supports, the command is aborted. Power-on default has the read look-ahead and write caching features enabled. The acceptable values for the Features register are defined as follows:

Table 12 Set Features command

02 _H	Enable write cache (<i>default</i>).
03 _H	Set transfer mode (based on value in Sector Count register). Sector Count register values:
00 _H	Set PIO mode to default (PIO mode 2).
01 _H	Set PIO mode to default and disable IORDY (PIO mode 2).
08 _H	PIO mode 0
09 _H	PIO mode 1
0A _H	PIO mode 2
0B _H	PIO mode 3
0C _H	PIO mode 4 (<i>default</i>)
20 _H	Multiword DMA mode 0
21 _H	Multiword DMA mode 1
22 _H	Multiword DMA mode 2
40 _H	Ultra DMA mode 0
41 _H	Ultra DMA mode 1
42 _H	Ultra DMA mode 2
43 _H	Ultra DMA mode 3
44 _H	Ultra DMA mode 4
45 _H	Ultra DMA mode 5
46 _H	Ultra DMA mode 6
10 _H	Enable use of SATA features
55 _H	Disable read look-ahead (read cache) feature.
82 _H	Disable write cache
90 _H	Disable use of SATA features
AA _H	Enable read look-ahead (read cache) feature (<i>default</i>).
F1 _H	Report full capacity available

Note

At power-on, or after a hardware or software reset, the default values of the features are as indicated above.

5.3.3 S.M.A.R.T. commands

S.M.A.R.T. provides near-term failure prediction for disk drives. When S.M.A.R.T. is enabled, the drive monitors predetermined drive attributes that are susceptible to degradation over time. If self-monitoring determines that a failure is likely, S.M.A.R.T. makes a status report available to the host. Not all failures are predictable. S.M.A.R.T. predictability is limited to the attributes the drive can monitor. For more information on S.M.A.R.T. commands and implementation, see the *Draft ATA-5 Standard*.

SeaTools diagnostic software activates a built-in drive self-test (DST S.M.A.R.T. command for D4_H) that eliminates unnecessary drive returns. The diagnostic software ships with all new drives and is also available at: <http://seatools.seagate.com>.

This drive is shipped with S.M.A.R.T. features disabled. Users must have a recent BIOS or software package that supports S.M.A.R.T. to enable this feature. The table below shows the S.M.A.R.T. command codes that the drive uses.

Table 13 S.M.A.R.T. commands

Code in features register	S.M.A.R.T. command
D0 _H	S.M.A.R.T. Read Data
D2 _H	S.M.A.R.T. Enable/Disable Attribute Autosave
D3 _H	S.M.A.R.T. Save Attribute Values
D4 _H	S.M.A.R.T. Execute Off-line Immediate (runs DST)
D5 _H	S.M.A.R.T. Read Log Sector
D6 _H	S.M.A.R.T. Write Log Sector
D8 _H	S.M.A.R.T. Enable Operations
D9 _H	S.M.A.R.T. Disable Operations
DA _H	S.M.A.R.T. Return Status

Note

If an appropriate code is not written to the Features Register, the command is aborted and 0x04 (abort) is written to the Error register.



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